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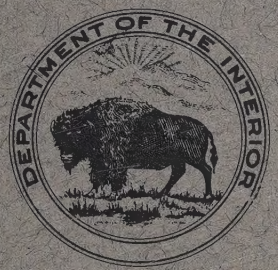

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FISH AND WILDLIFE SERVICE

PROGRESSIVE FISH-CULTURIST

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The PROGRESSIVE FISH-CULTURIST
News and Views from many Sources on Practical Hatchery Problems

Volume 9 Chicago, Ill. July 1947 Number 3

SULFAMERAZINE IN THE TREATMENT OF TROUT FOR FURUNCULOSIS AND ULCER DISEASE

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State Fish Hatchery
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Attempts were made to check two diseases of trout by oral administration of sulfamerazine. One of these diseases, furunculosis, is caused by Bacterium salmonicida; the other, ulcer disease, is probably a bacterial infection, but the causative organism is not yet known. Brook, brown, and lake trout infected with furunculosis, and brook trout infected with ulcer disease were the subjects of the experiments. Sulfamerazine was administered in the feed at the rate of 3 grams per pound of feed.

The evidence indicates that both diseases can be checked by the drug. Optimum dosage is not yet known, however, and under actual hatchery conditions the cures may be only partial and temporary. The selection of strains of fish resistant to these two diseases is still considered desirable.

PUBLICATION by Gutsell (1946) of his results with the use of sulfamerazine for furunculosis in trout constituted a long-awaited event in the annals of fish culture. Here, for the first time, was extended some hope of conquering this dread disease by a very simple method of chemical therapy. Immediately upon hearing of Gutsell's work, the writer procured a small quantity of the drug and hoped for an opportunity to try it. This appeared when, during the summer of 1946, an epidemic of furunculosis occurred at the Rome, New York, hatchery--the first such epidemic in the 12-year history of the establishment.

The Rome hatchery is the largest in New York State and supplies a very considerable proportion of all the brown trout produced in the State. When furunculosis broke out it threatened to work

See also:

Gutsell, J. S.
1947. Furunculosis and its treatment. Prog. Fish-Cult. 9 (1): 13-20.

havoc with the planting schedule of the Bureau of Fish, and so the chief efforts of the writer had to be directed toward saving fish rather than toward performing experiments. The experience gained with the use of sulfamerazine is related in the following pages under the headings of numbered "experiments." The word is used very freely, however, more as a device for breaking up the presentation into digestible units than in its exact sense.

Considerable difficulty was experienced in obtaining sufficient sulfamerazine, as the manufacturer did not have large stocks on hand. This frequently interfered with planned treatments and was partly responsible for the piecemeal character of many of the "experiments." About $1,000 worth of the drug was used. Shortage of manpower prevented the taking of daily mortality records over as long a period as would have been desirable in some instances.

The earliest information regarding the dosage to be used in treating diseased trout suggested 8 grams per day per 100 pounds of trout, to be continued for 6 days after the mortality was reduced to normal.[1] This suggestion was the basis for the dosage used at Rome but was translated into terms of grams per pound of feed. The first trials of the drug were made on some 7-inch yearling brook trout infected with ulcer disease (Wolf, 1938). According to the tables of Deuel and Tunison (1944), fish of this size in water at 50° F. will consume 2.6 percent of their body weight daily. The recommended dosage of 8 grams per 100 pounds of fish would, in this case, become 8 grams per 2.6 pounds of feed or 3 grams per pound. When it was seen that these trout (and fingerlings, too) could consume this mixture without immediate injury, it was decided to use this proportion throughout the treatments rather than embark upon a limitless series of variations which would be more difficult to evaluate in the end. In the main this was done. It is not claimed that this is the optimum proportion.

[1]Meehean, O. L. Memorandum to Regional Directors and Project Leaders, Division of Game-fish and Hatcheries, Fish and Wildlife Service. Feb. 21, 1946.

EXPERIMENT 1. FURUNCULOSIS IN BROOK TROUT

During the summer of 1946 brook trout fingerlings were being reared in outdoor troughs at the Rome hatchery. From July 1 through July 23, these fish were in good health and the average daily mortality was 15 fish. On July 24 the mortality jumped to 41, and it continued to rise thereafter. Beginning July 31, the losses ranged between 200 and 300 fish per day.

It was suspected that the fish were suffering from furunculosis, and this was later confirmed by isolation of Bacterium salmonicida. The symptoms exhibited by the fish were not at all decisive; so at the time the following experiment was begun, the diagnosis was only provisional.

Some 700 of the fish were removed to a separate trough on August 7 in order to determine their tolerance for sulfamerazine should treatment of the main lot be undertaken. After a preliminary control period of 1 week, treatment with sulfamerazine was begun on August 15 and the fish were thenceforth fed once daily on a diet containing 3 grams of sulfamerazine per pound of feed. This dosage was continued through August 26 (a period of 12 days), but no drug or feed was given on the two Sundays included in this period.

Mortality declined sharply during the time of treatment but toward the end began to rise again. (See table 1.) The surviving fish were thereafter divided into two lots (308 fish in each), and the sulfamerazine was continued as before in one of these but eliminated in the other. This schedule was followed through September 13, when the drug was discontinued in lot 1, also.

The data in table 1 indicate that mortality from disease stopped about 10 days after treatment was begun and that then a secondary mortality (perhaps caused by the drug itself) began. Furunculosis was apparently checked by the treatment, as shown by the absence of mortality in lot 2--and in lot 1 after the drug was discontinued.

The data also indicate that while some loss can be caused by drug injury, with the dosage here used there is little danger of any really serious mortality as long as voluntary consumption of the drug is depended upon. The most casual observation of the fish during feeding shows

TABLE 1.--Mortality of brook trout from furunculosis

Date	Mortality		Remarks
Aug. 7-9	20		707 fish in all.
10-12	24		
13-15	20		Drug started Aug. 15.
16-18	9		
19-21	3		
22-24	1		
25-27	14		
	(Lot 1)	(Lot 2)	Two lots formed. 308 fish in each. Drug continued in lot 1 only.
28-30	2	0	
31-Sept. 2	9	0	
3-5	7	0	
6-8	6	0	
9-11	7	0	
12-14	6	0	Drug discontinued after 13th.
15-17	4	0	
18-20	0	0	
21-Oct. 2	0	0	
Total	41	0	

that after a certain period of treatment food consumption falls off very greatly, and therefore drug consumption falls off likewise. This creates an effective barrier to any serious overdosage. When fish under treatment show a rise in death rate after a previous drop, this should constitute a warning that the limit of effective dosage has been reached.

EXPERIMENT 2. FURUNCULOSIS IN BROOK TROUT

After it had been shown that sulfamerazine effectively checked the losses in the brook trout, it was decided to treat the main body from which the 700 had been taken. These trout were in 10 series of troughs, 3 troughs to a series. Three series (two of the best and one of the worst) were used as a check and given no treatment whatever. The remaining seven series were given sulfamerazine in their feed at the rate of 3 grams per pound of feed. All fish were fed twice a day.

In table 2 the mortality figures for these trout are presented. The figures for each of the three untreated series are given individually because of the interesting differences in trend exhibited. The figures for the seven treated series are lumped because the trend was the same in all. All troughs had about the same number of trout before losses started to rise on July 24, 1946. The mortality figures are given for a 2-day control period preceding the administration of sulfamerazine. It should be noted that the figures for the last 2 days are for all 10 series of troughs: individual figures were not obtained. Observations could not be extended beyond the period shown in Table 2 because the fish were removed from the hatchery at this time.

The figures in table 2 show a decline in mortality beginning in the treated troughs 2 days after treatment started and continuing until about the eighth day. Thereafter the losses rose again and did not drop until several days after treatment was terminated. Drug injury was probably the cause of this rise.

TABLE 2.--Mortality of brook trout fingerlings from furunculosis

Date	No sulfamerazine Series 1	Series 2	Series 3	Total 1-3	Sulfamerazine Series 4-10	Remarks
Aug. 20-21	0	82	0	82	327	
22-23	0	80	0	80	263	Drug started on Aug. 22.
24-25	1	72	0	73	132	
26-27	2	62	0	64	37	
28-29	1	59	3	63	44	
30-31	2	18	4	24	106	
Sept. 1-2	9	26	11	46	181	Last drug on Sept. 2
3-4	5	21	9	35	283	
5-6	7	25	20	52	67	
7-8					50	Total for series 1-10.

In series 1 and 3 of the untreated fish the mortality was late in starting, but the trend was upward at the termination of observations. The figures for series 2 are disturbing in that they show a downward trend even though no drug was administered. This may indicate that the strain of bacteria was not particularly virulent or that the trout had much natural resistance.

On September 4 smears from the kidneys of five weak fish--two from the untreated group and three from the treated--were examined. One of the smears from an untreated fish was full of bacteria, presumably B. salmonicida. All the others were free from bacteria.

From the results shown in table 2 it is not certain just what effect the sulfamerazine had upon the course of the disease. The effect was probably beneficial, but observations could not be continued long enough to prove this. Drug injury showed up after about 8 days of treatment.

EXPERIMENT 3. FURUNCULOSIS IN LAKE TROUT

In September 1946 a group of lake trout fingerlings held in rearing troughs contracted furunculosis. The diagnosis was confirmed by isolating B. salmonicida from the kidneys of several fish. The disease, as far as could be determined, was confined to a single series of troughs; but no precautions had been taken to prevent spread of the infection.

Beginning with the evening feeding of September 3, sulfamerazine was administered to the infected series at the rate of 3 grams per pound of feed. Thenceforth, through the evening feeding of September 7 (a total of a little more than 4 days), the fish were fed three times a day on medicated feed. Because of shortage of the drug, it was then discontinued.

Losses dropped from an average of 18 a day at the start to 2 a day after the treatment stopped, and they continued low for several weeks. On September 26 the number of deaths began to rise again in the same series, and again B. salmonicida was isolated.

This time a sufficient supply of sulfamerazine was on hand to treat the entire lot. Used first on the morning of September 28, the drug was administered at the rate of 3 grams per pound of feed. All fish were fed three times a day, but only the morning and evening feeds contained the drug. This was continued until October 2, upon which day the drug was administered only in the evening, and so continued through October 4 (a total of 7 days).

The losses decreased from a high of 62 on the day treatment started to 24 on the day it was discontinued. The 7-day dosage seemed to have reduced the mortality, but not so sharply as in the previous trials; and subsequent events showed that furunculosis had not been eliminated by the treatment. It seems probable that the considerably smaller feed consumption of lake trout, as compared with brook trout, may have been responsible for this lack of success. Observations on these fish were terminated because some were removed from the hatchery on October 5, and all the rest were removed to one of the hatchery ponds.

After the lake trout were removed to a pond, the mortality continued to drop until it reached a low of five fish dead for the 3 days of October 8-10. On October 13 the losses suddenly shot up to 106. Again furunculosis (bacteriologically confirmed) was found rampant. On October 17 a third course of sulfamerazine treatments was started with the evening feeding. This time a little less of the drug was used (2.27 grams per pound of feed, or 0.5 percent of the diet) in an effort to keep up the food consumption, and the drug was administered at the evening feeding only. The other two feedings were drugless. This was continued through October 23 (7 days). Losses dropped from around 200 per day at the start of treatment to 35.

Mortality continued low for several days, and again it appeared that the sulfamerazine had checked the disease. On November 2 the losses suddenly rose once more, and on November 5 a final course of treatments was begun. Before the details of these last treatments are given, the situation with regard to the pond containing the lake trout should be explained.

While the lake trout were still in troughs, the effluent from these troughs entered the second pond of a series of six. Pond 1 of the series was supplied entirely with pure spring water piped directly from its source. It contained brown trout fingerlings. Pond 2 received the effluent from pond 1 and from the battery of troughs containing the lake trout. This pond also contained fingerling brown trout which, although they received the water from the diseased lake trout, never did develop any abnormal mortality. The lake trout were placed in pond 3 when removed from the troughs on October 5. The last three ponds of the series were filled with brown trout fingerlings which also, up to this time, had not shown symptoms of disease.

When furunculosis again became active in the lake trout in pond 3, it was decided to administer sulfamerazine to all the fish in the series of six ponds. A sufficient supply of the drug could not be obtained immediately; so treatment of the brown trout did not begin till 10 days after the start of the final treatments of the lake trout. The details concerning the brown trout will be presented in the next section: only the data regarding the lake trout are given in this section.

On November 5 sulfamerazine administration to the lake trout was again begun at the rate of 3 grams per pound of feed. The drug was used only in the evening, the other two daily feedings containing none.

Sulfamerazine was administered once daily from November 5 through 23, except on one Sunday. The treatment thus covered a period of 19 days. Mortality figures for this period are given in table 3.

TABLE 3.--Furunculosis mortality, lake trout in pond

Date	Mortality	Remarks
Nov. 2	98	First day of high mortality.
3-4	627	
5-6	680	Drug started on 5th.
7-8	754	
9-10	236	
11-12	139	
13-14	87	
15-16	49	
17-18	65	Drug omitted on 17th.
19-20	46	
21-22	54	
23-24	30	Last drug on 23d.
25-26	21	

Reference to table 3 will show that losses in the lake trout dropped very

sharply after the sixth feeding of the drug and receded steadily thereafter. No marked losses from drug injury occurred even after the nineteenth day of treatment. This differs from the results obtained with brook trout, but it is to be noted that the latter received the drug at every feeding, whereas the lake trout received the drug in every third meal. Also, lake trout consume less feed in terms of percent of their own body weight.

It should be remarked that the lake trout showed loss of appetite from the continued administration of the drug, and food consumption decreased throughout the period of treatment. The monthly sampling and weighing, made on every lot of fish at the Rome hatchery, showed no gain whatever in weight for the lake trout during November.

Up to the time of the present writing (February 14, 1947) there has been no new outbreak of furunculosis in the lake trout.

EXPERIMENT 4. FURUNCULOSIS IN BROWN TROUT

The presence of furunculosis in the brown trout in pond 6 of the series described in the preceding pages was clearly indicated on October 29, 1946, and later confirmed bacteriologically. However, a sufficient supply of sulfamerazine to begin treatments could not be obtained until November 15. On that date the drug was added to the feed of all the fish in ponds 1, 2, 4, 5, and 6 at the rate of 3 grams per pound. These trout were fed once a day. No drug was given on November 17, but it was resumed on the following day and continued through the 23d (a total of 9 days). In table 4 the combined data for ponds 4 to 6 are given for the period of observation. Ponds 1 and 2 are not included, for at no time did any abnormal losses occur in these.

The data in table 4 indicate a decided check in mortality through use of the sulfamerazine. There has been no new outbreak of this disease in the ponds up to the time of the present writing (February 14, 1947).

The monthly sampling and weighing of the brown trout in all the above-mentioned ponds showed a very low gain in weight for November. The drug had interfered with the normal food consumption and the growth of the trout.

TABLE 4.--Mortality of brown trout from furunculosis

Date	Mortality	Remarks
Nov. 12	129	
13	135	
14	111	
15	?	Data lost. Drug started.
16-17	88	Drug omitted on 17th.
18-19	59	
20-21	56	
22-23	23	Last drug on 23d.
24-25	16	
26	8	

EXPERIMENT 5. FURUNCULOSIS IN BROWN TROUT

At the Rome hatchery there are 15 ponds which receive the effluent from all the troughs and ponds so far mentioned. Most of these 15 ponds (some were empty) were filled with brown trout fingerlings, and these fingerlings were therefore subjected to furunculosis from the very first outbreak of the disease in July 1946 until the final drop in losses in the middle of November (Experiment 4).

At the time that a diagnosis of furunculosis was first confirmed in the brook trout, it was likewise confirmed in the brown trout in some of the 15 ponds just mentioned.

Because of lack of sufficient sulfamerazine it was impossible to treat all the trout in the lower ponds. Therefore, four of the worst, comparable in number of fish, were selected for observation. Of these four ponds, the worst two were treated with the drug and the other two were used as a check. All the fish were fed twice a day, and the sulfamerazine was fed at the level of 3 grams per pound of food at each feeding.

In table 5 the data are given for the four ponds. Pond 15 was immediately below pond 10 in one series; ponds 13 and 14 were each in a different series.

The sulfamerazine was discontinued in

TABLE 5.--Mortality of brown trout from furunculosis

Date	No sulfamerazine		Sulfamerazine		Remarks
	Pond 10	Pond 13	Pond 14	Pond 15	
Aug. 20-25	276	268	328	438	2-day averages.
26-27	230	193	219	426	Drug started on 26th.
28-29	291	230	101	195	
30-31	151	124	57	61	
Sept. 1-2	110	71	98	125	Last drug on 2d.
3-4	148	117	124	150	
5-6	109	67	247	292	
7-8	80	71	178	241	
9-10	54	23	44	53	
11	27	14	23	6	
Total trout Aug. 1	17,319	22,630	24,532	21,121	
Total trout Sept. 18	13,620	16,440	18,320	15,400	
Total loss (percent)	21.4	27.3	25.3	27.0	

ponds 14 and 15 after the eighth day because of rising mortality (which could have indicated drug injury) and because the food consumption in these fish had fallen off to the point where they got very little of the drug. The fish in the other two ponds still ate well.

Reference to table 5 will show that the losses in ponds 14 and 15 fell off after treatment, but so did the mortality in untreated ponds 10 and 13. When observations were terminated, the untreated ponds had made just about as good a recovery as had the treated ponds. These results therefore indicate little, if any, benefit from treatment with sulfamerazine. A disadvantage of the medication was that the fish in ponds 14 and 15 did not recover their appetites and resume feeding until about a week after termination of treatment. During all this time they clung to the bottom of the pond instead of being normally suspended in the water.

On September 18 the fish in the four ponds were sorted and removed to other ponds. At this time an accurate count of the number in each pond was obtained. If the entire mortality for each pond from August 1 to September 18 (this includes the entire period of losses from furunculosis) is compared with the final population figures, the total mortality from the disease in these ponds is as follows: Pond 10, 21 percent; pond 13, 27 percent; pond 14, 25 percent; pond 15, 27 percent.

This is a very low mortality when compared with reports found in the literature. Perhaps this low mortality indicates, as before mentioned, that the strain of bacteria was not particularly virulent or that the fish were rather resistant. The spontaneous recovery of the fish in ponds 10 and 13 also indicates the need for caution in claims made for therapeutic measures.

In spite of the constant source of infection from these ponds which contained infected fish at least up to the middle of November 1946 (Experiment 4), there has been no new outbreak of the disease in any of the ponds up to the present writing (February 14, 1947).

EXPERIMENT 6. ULCER DISEASE IN BROOK TROUT

On October 4, 1946, some 600 healthy brook trout were put in a rearing trough that had an uninfected water supply, and

they were infected with ulcer disease by placing with them eight diseased specimens. By October 15 the disease had become well established, and the trout were then divided into six lots, 90 fish in each, and placed in separate troughs, each with a separate water supply. Although the division was made at random, observations on the six lots showed about the same number of external lesions of ulcer disease in each lot.

On October 16 sulfamerazine treatments were started in five of the lots, one being held as an untreated check. The drug was mixed into the feed at the level of 3 grams per pound, but in lots 5 and 6 the amount was reduced to 2 grams during the last 4 days. All fish were fed once a day according to the following plan:

Lot 1 -- No drug
Lot 2 -- Drug, 5 days, full dosage
Lot 3 -- Drug, 8 days, full dosage
Lot 4 -- Drug, 11 days, full dosage
Lot 5 -- Drug, 4 days, full dosage
4 days, reduced dosage
Lot 6 -- Drug, 6 days, full dosage
4 days, reduced dosage

Detailed mortality records for these lots will not be given. The total losses in 18 days after the final treatment in lot 4 were as follows:

Lot 1 -- 80 dead
Lot 2 -- 38 dead
Lot 3 -- 18 dead
Lot 4 -- 24 dead
Lot 5 -- 28 dead
Lot 6 -- 24 dead

At the termination of observations fish were still dying with typical ulcer-disease lesions in all groups but lot 6, and even in this lot some of the survivors still exhibited symptoms.

It is therefore obvious that no complete cure was effected in any lot. The disease was checked to some extent, however, as shown by the reduced losses in all the treated lots. Since lots 3 to 6 all had a mortality lower than that of lot 2, it would appear that at the level used here the treatments should extend well over 5 days.

EXPERIMENT 7. ULCER DISEASE IN BROOK TROUT

In this experiment further observations were made on the effects of sulfamerazine on ulcer disease. For lack of space it was not possible to run a check with untreated fish, but the results obtained appear to be sufficiently decisive to warrant recording. The writer has had much experience with ulcer disease and has never seen a case of spontaneous recovery in a susceptible stock of fingerlings confined to a trough or aquarium.

On the last day of July 1946, 32 diseased brook trout fingerlings and 18 uninfected specimens were placed in a large aquarium provided with running water. These fish were fed from August 1 through August 17 on a diet containing 3 grams of sulfamerazine per pound of feed. They were fed once a day.

At the termination of treatment 10 of the 50 fish had died. Though observations were continued to November 25, not another fish died during this 100-day period. The treatment appeared to have effected a complete cure, also to have caused no noticeable drug injury.

The drug, besides diminishing the food consumption of the fish, affected them in a peculiar manner which was strikingly apparent in the aquarium. After about 1 week of dosage all the fish remained almost constantly on the bottom of their aquarium. Also, their eyes became much darkened. Both these effects continued for about 1 week after the drug was discontinued. At this time there were no more open lesions on any of the fish, but about half had black scars from ulcers which had healed.

On September 18, 32 days after the last fish had died, five healthy brook trout were introduced into the aquarium to see whether, in spite of absence of symptoms in the treated fish, new specimens might contract the disease. These five fish had their adipose fins clipped for identification. At the same time five identically marked fish were placed with another group of actively diseased trout in a trough. By November 4 all

five of the latter had succumbed to the disease, whereas no symptoms whatever had appeared on the five in the aquarium.

On November 4 eight marked fish from an infected lot were introduced into the aquarium. These eight were all ulcered. By November 25 the disease had spread to the other fish in the aquarium and it was clear that trout which had recovered through treatment with sulfamerazine were still susceptible to the disease.

EXPERIMENT 8. ULCER DISEASE IN BROOK TROUT

During November 1946 a group of healthy brook trout fingerlings was subjected to ulcer disease. By December 10 the fish were infected and some had died. The survivors were divided into three lots as follows: Lot 1, 300 fish; lot 2, 150 fish; lot 3, 150 fish. Administration of sulfamerazine was begun in lots 1 and 2, lot 3 serving as a check. All fish were fed once a day. The diet of lot 1 contained sulfamerazine at the rate of 3 grams per pound throughout the period of treatment, but in lot 2 the amount of drug was changed several times. Since these changes produced no significant results, they will not be explained here.

In lot 1 treatment was terminated on January 5, 1947. In lot 2 it was continued on a much-reduced scale and not terminated until January 23. None of the fish was fed on Sundays or on two holidays which occurred during the period of treatment.

The mortality record for the three lots is given in table 6. On January 3 all lots were carefully inspected. Lot 3 exhibited all the symptoms characteristic of ulcer disease. Lots 1 and 2 showed very few signs of disease: even the fish which died on that day were free from lesions. It appeared that in lot 1 fish were dying from overdosage of the drug rather than from the disease. No sulfamerazine was fed to lot 1 after January 5. There was an immediate drop in mortality after the drug was eliminated.

The mortality figures alone do not tell the whole story. In lot 1 the last 17 fish that died during the period of treatment died from drug injury rather than disease. None of the fish which died in either of the treated lots after January 7 exhibited the slightest sign of ulcer disease. Some of them were very much undersized fish which probably died from some constitutional weakness. No signs of ulcer disease were visible in lot 1 or 2 at the termination of observations on February 14. The eight survivors of lot 3, on the other hand, were all obviously diseased and apparently doomed.

In this case the drug treatments seem to have effected a complete cure.

DISCUSSION

The results obtained at the Rome hatchery by the use of sulfamerazine support the belief that this drug may become a useful weapon against furunculosis, ulcer disease, and perhaps other bacterial diseases of trout. Just how effective it will be must await further trials under various conditions. The present price of the drug (more than $16 per pound) and limited production will prevent its wide use for the time being, but these may be temporary obstacles.

Other obstacles may arise, however, as they have arisen with other sulfonamides. It is possible that drug-resistant strains of bacteria may appear. It is possible that symptomless carriers may be created.

The writer is strongly of the opinion that the selection of disease-resistant strains of trout is now, and always will be, a desirable project--regardless of any foreseeable advances in chemical therapy. Much lip service has been rendered this idea in fishery circles, but little serious work has actually been undertaken.

SUMMARY

1. In trials at the Rome, New York, hatchery mortality from furunculosis in brook trout fingerlings was checked by a dosage of 3 grams of sulfamerazine per pound of feed, continued for a 12-day period, the fish being fed all they would eat once daily. There were some losses from drug injury before the end of this period.

2. In lake trout fingerlings mortality from furunculosis was checked by a similar dosage continued over a period

TABLE 6.--Mortality of brook trout from ulcer disease

Date	Sulfamerazine Lot 1 (300 fish)	Sulfamerazine Lot 2 (150 fish)	No sulfamerazine Lot 3 (150 fish)	Remarks
Dec. 11-13	3	4	1	Drug started Dec. 10
14-16	4	7	5	
17-19	4	6	6	
20-22	6	4	9	
23-25	3	6	12	
26-28	2	4	19	
29-31	4	0	9	
Jan. 1-3	7*	2	14	*Drug injury.
4-6	10*	1	15	*Drug injury. Last drug on 5th.
7-Feb. 14	7	6	52	
Survivors Feb. 14	250	110	8	

of 19 days. Throughout this period these fish were also fed twice daily on unmedicated food.

3. In brown trout fingerlings losses from furunculosis were checked by similar dosage for a period of 9 days.

4. In all trials with sulfamerazine in the treatment of ulcer disease of brook trout mortality was reduced. In one case all losses stopped and symptoms vanished after the drug was administered once daily for 17 days at the rate of 3 grams per pound of feed.

5. It is felt that the dosage here used is not optimum. It is suggested that the dosage be started at 3 grams per pound of feed and be reduced as food consumption falls off.

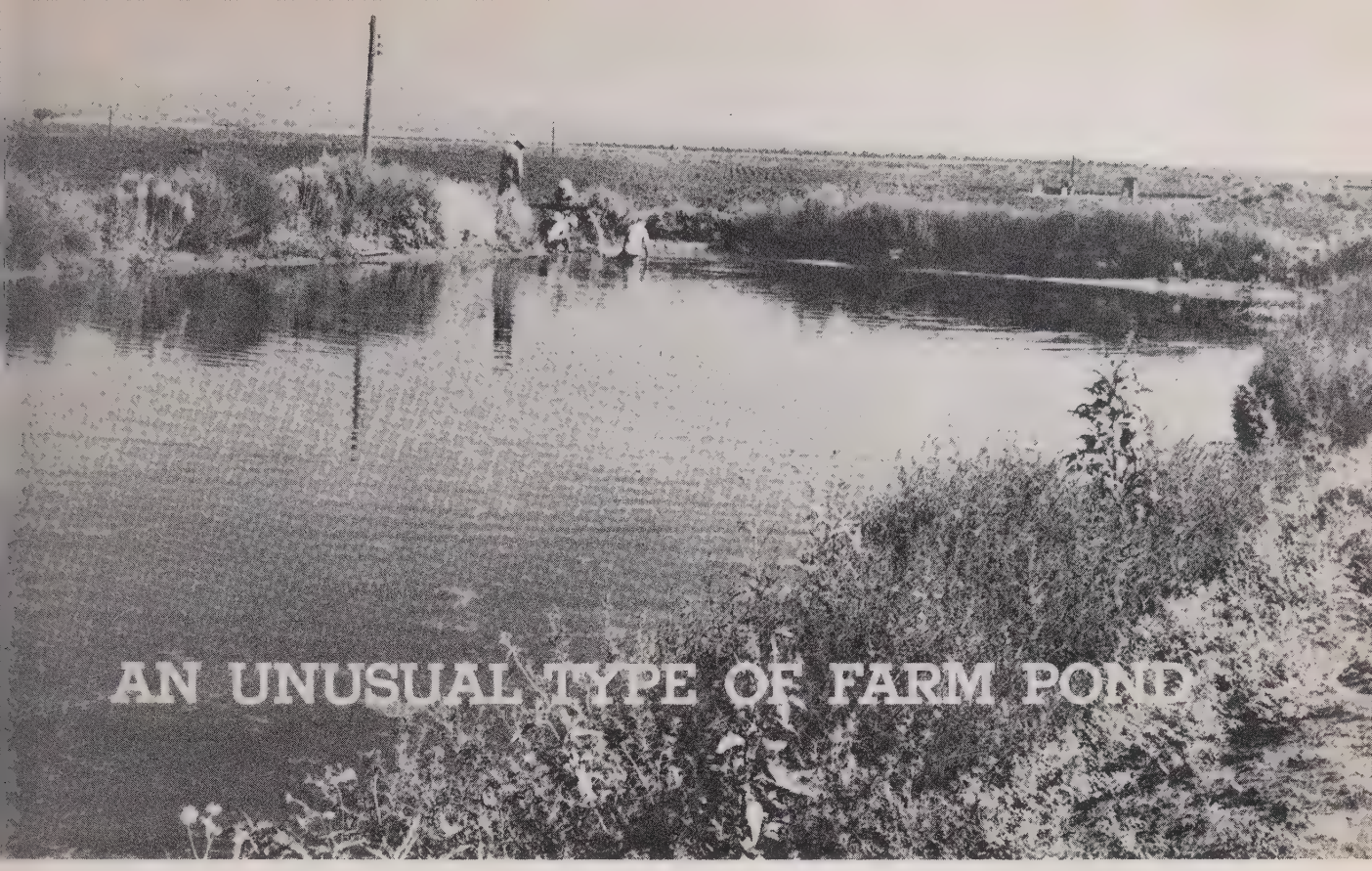
6. There is little danger of any serious losses from drug injury if treatment is discontinued when losses begin to rise.

LITERATURE CITED

Deuel, C. R., and Tunison, A. V.
1944. Feeding tables for trout (revised). New York State Cons. Dept., Bureau of Fish. Albany.

Gutsell, J. S.
1946. Sulfa drugs and treatment of furunculosis in trout. Science 104: 85.

Wolf, L. E.
1938. Observations on ulcer disease of trout. Trans. Amer. Fish. Soc. 69: 136-151.



AN UNUSUAL TYPE OF FARM POND

(Photos courtesy of Soil Conservation Service)

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In certain areas of the mesquite country of southern New Mexico and Arizona, water is pumped by night into "tanks" and drawn off by day as required for irrigation purposes. Bass reproduce successfully in these ponds; the difficulty has been to find a forage fish that will spawn in the low water temperatures occurring most of the time. Investigations indicate that tanks permitted to retain the water for periods longer than 24 hours will furnish satisfactory crops of bass and bluegill sunfish of desirable size. Increased fishing pressure has been necessary to control excessive populations.

IN GENERAL APPEARANCE, the farm fish pond is more or less the same throughout most of the country. Everyone is familiar with its grass-covered banks, willow-lined shore, and the several large trees--cypress in the South, cottonwood in the North--that provide shade for barefoot boys fishing with willow poles for bluegills, or the more expert angler landing 2- and 3-pound bass, or, as pictured in some farm-pond publications, beauteous girls wearing brief play suits and proudly presenting a string of fish that would in themselves appeal to the angler. Ordinarily, the farm-pond booklet shows these ponds in green pastures of forage for cattle and other stock or in a woodland glen--a charming, pastoral scene. This type of pond is usually fed by cool, clear springs, rippling brooks, or run-off from surrounding terraced and well-managed lands.

In considerable contrast is the type of pond found throughout the southern portion of New Mexico and Arizona. There are hundreds of ponds in this area. In the vicinity of the modern and thriving city of Douglas, Arizona, are more than a hundred ponds of the type constructed in this section of the country. In an attempt to determine whether or not this type of pond is suitable as a habitat for fish, a number of ponds in this vicinity have been inspected each year for the past 3 years. This work is being conducted by the Fish and Wildlife Service in cooperation with the Soil Conservation Service office in Albuquerque, New Mexico. Mr. A. E. Borell, Chief of the Regional Biology Division, and other personnel of that agency have taken a leading part in this observational work.

The Douglas area is mesquite country, and there is sunshine nearly every day throughout the year. The average rainfall in a year is slightly more than 13 inches, 8 inches of which may be received in July, August, and September. The long summer is "hotter than Hades," the mercury often hovering around 110° to 115° F. Here the girl in her brief play suit can certainly be assured of a most beautiful sun tan!

Most of the ponds in this area are on small farms that have been carved out of mesquite-covered flats. When mesquite has been removed and the land leveled, deep medium soils of sandy or silty-loam texture permit farmers to raise chili, melons, peanuts, onions, beans, sweet potatoes, and alfalfa. It may be noted, as an example of the long growing period, that five cuttings of alfalfa are made each season, these providing a total average of 5 tons per acre.

To construct one of these ponds, the owner scoops out an area. The earth thus obtained is used in building an embankment, by which is created a "tank," as a pond is commonly called in this section of the country. The primary purpose of the ponds is the storage of water for irrigation. They are supplied by electric-powered pumps that draw water from about 50 feet. Water is pumped into the ponds during the night. The water available for irrigation purposes the following day is the amount that can be stored above the ground level, and this water is drawn off through a screened irrigation outlet; the remainder (one-half to one-third of the pond capacity) could be termed a "conservation pool."

The ponds in the Douglas area and in southern Arizona and New Mexico range from 1/5 to 1 acre in size. In nearly all ponds, the water stored for irrigation purposes is from one-half to two-thirds the total of that in the pond. Usually, when the pond is full, the water is about 6 feet deep; when the water is drawn down, the depth is from 2 to 3 feet. Irrigation may continue daily during the growing season; the water may fluctuate every 24 hours. Depending upon the crop raised, however, there are periods during which the water is allowed to remain in the ponds for a longer time, sometimes as much as 2 weeks. During the short non-growing season (from November to March) the ponds remain full. The temperature of the water flowing into the ponds is generally around 68° F., which is rather low considering the high air temperature prevalent the greater part of the year.

Fish-culturists unfamiliar with this type of farm pond are apt to discount its possibilities as habitat for fish and to disapprove altogether the stocking of such ponds. When properly managed, however, they do produce a satisfactory number and poundage of fish. Unlike the farm fish pond found in other parts of the country, where fish sometimes are not fully appreciated or the recreational use is not fully exploited, these ponds are recognized as a source of both food and recreation. In this semi-arid land where lakes and flowing streams are often too far distant for the average person, the fishing provided by these ponds affords great pleasure for all members of the farm family and their city friends, who would not otherwise be able to enjoy the taking and eating of fish.

There are, of course, some difficulties involved in the propagation of fish in these ponds. Surprising as it is, in this area where the summer air temperature reaches a point that may hardly be mentioned without incurring the displeasure of the Douglas Chamber of Commerce, the greatest difficulty results from the low water temperature, which interferes with the spawning of bluegill sunfish. Investigations of ponds in this area have disclosed that the constant drawing-off

On July 29, 1946, the water temperature was 69½° at well (on right) and 70° F. in pond.

of the water does not allow the temperature to rise high enough for the spawning of bluegills. Where reproduction does occur, investigation has disclosed that those ponds remain full for periods of several days during the summer. It has been found that conditions may allow reproduction one year but not the next. When the ponds are being drawn off every day, the water (except for a few inches at the surface) will remain in the low seventies; however, if allowed to stay in the ponds for a longer period, the temperature will rise into the nineties.

Bass reproduce successfully in these ponds. In most of those examined each season, evidence of spawning has been found. This reproduction has proved that the fluctuation of water level in itself has not interfered with the spawning of the largemouth bass and probably does not hinder the spawning of bluegills. In several ponds an overproduction of bass has been found.

These waters have been stocked with the bass-bluegill combination--100 to 1,000 per acre for fertilized waters, half this number for unfertilized. Several ponds in the area contain bullhead catfish (Ameiurus melas) obtained a few years ago, before the establishment of the bass-bluegill combination. As these bullheads appear to reproduce satisfactorily, last season it was decided to stock them with bass in several ponds: it was expected that the bullheads, tried as forage fish, would last for at least a few years.

In an effort to find a forage fish willing to spawn in colder water, two ponds were stocked with yellow perch (Perca flavescens) in 1946, and consideration is being given to the stocking of rock bass in a pond or two during 1947. So far, the erratic reproduction of bluegills has not appeared to affect adversely the production of fish in the ponds, and it is possible that the uncertainty of the production of forage fish is not a matter of great importance.

The ponds throughout this area, as well as those in the southern parts of New Mexico and Arizona, are generally stocked by the Fish and Wildlife Service on an unfertilized basis. The land is deficient in phosphoric acid and nitrogen and thus requires considerable fertilizer. The fertilizer most often used is ammonium sulphate. Farm owners recognize the need for fertilizers, but these products have been difficult to obtain. Furthermore, since the water is drawn off frequently, the effect of fertilizers is reduced. However, fertilizers placed in the ponds are not lost, as the nutrients are carried through irrigation water to the crops. Despite the soil deficiency, some of the ponds are surprisingly fertile. This richness is, no doubt, due partially to the nitrogen content of the water. Some ponds contain a rich "water bloom" without being fertilized, and nearly all ponds contain some vegetation. A few farmers

fertilize with chicken manure and phosphate.

In the Douglas area fish make rapid growth, as illustrated by the Dillman Ranch pond. Its record is as follows: On November 5, 1943, the Fish and Wildlife Service stocked this 3/4-acre pond with 30 largemouth black bass (No. 4) and 300 bluegill sunfish (No. 3). On May 20, 1944, it was found that the bass were 7 inches long and the bluegills were from 3 to 5-1/2 inches long. On April 3, 1945, the original bass were 13 and 14 inches long and the bluegills were 6 to 8-3/4 inches long. During 1944 the original stock of bluegills had spawned and numerous 2- and 3-inch fingerlings were taken. Apparently the bass had not spawned during 1944. This species did spawn extensively in 1945, however, after our inspection on April 3. The bluegills also spawned during 1945.

No reproduction of bluegills was noted during the inspection in July 1946. As this pond had been allowed to remain full of water for several periods each summer, an overpopulation of bluegills (which our 1945 inspection disclosed) probably prevented the spawning of this species in 1946; or possibly the heavy population of bass took all the 1946 hatch of bluegills. The bass had again spawned during this season.

During the latter part of 1944, the owner began the removal of bluegills by fishing with pole and line. One lot of 84, taken by Mr. Dillman and friends, weighed 25 pounds and included 4 fish that weighed 13 ounces each. Apparently the removal of a large part of the parent stock did not prevent an excessive number later. During 1945, bluegills of this size continued to be harvested in large numbers, and bass that weighed as much as 3 pounds were also being caught. During the early part of 1946, bass that weighed 1-1/2 to 2 pounds were being taken in satisfactory numbers.

Another example is the Saylor Ranch pond, which the Fish and Wildlife Service stocked on November 5, 1943, with 15 bass (No. 4) and 100 bluegills (No. 3). A check of this pond on April 3, 1945, revealed numerous 1- to 3-inch bluegill fingerlings (probably the 1944 reproduction), several bluegills that weighed 8-1/2 ounces each, bass fingerlings that were 3-1/2 to 4 inches long, and 12 bass that were 13 inches or more in length and weighed up to 2 pounds. There had been no fishing until this time, and there appeared to be an overpopulation of bluegill sunfish.

At the time of the 1946 inspection, it was found that both bass and bluegills had spawned during 1945 and 1946. Large bass and bluegills were taken from the pond and were in greater numbers than in the previous year. It was evident, however, that the fishing pressure was not great enough and that both species were present in excessive numbers. Here was evidence that a 1/4-acre pond, if fished heavily enough, could furnish considerable numbers of catchable-size fish.

The two ponds mentioned were allowed to go for periods without being drained, and the bluegills spawned each summer. Records were maintained on several other ponds, and there was no indication of the spawning of this species: the ponds contained bass of each season but only the original stock or one season's reproduction of sunfish.

Our investigations are handicapped by the inability to procure accurate catch records. Notwithstanding the interest shown in fish ponds in this area, the farmers are too busy with their farm crops to gather statistical data for "bureaucrats." Suffice it to say, however, that these ponds do produce a large number of bass and bluegills of a size that the most ardent angler would be pleased to catch.

It was difficult at first to convince the pond owners that they should harvest their fish crop. Quite naturally, they felt that they could better conserve their fish supply by limiting the fishing. As the ponds are being fished more and more, we believe that our propaganda has now begun to bear fruit. Peculiarly enough, we found that the average person--once he was convinced that by removing some of the fish from the pond, he could have more of a suitable size--did not know how to fish for them. The bass especially were difficult to take.

Now, although the "market price of alfalfa and farm truck" is still the predominant subject of conversation around the stores at the crossroads, the comparative merits of different bass plugs and other tackle are also topics of interest to farmers in pond areas.

During the summer of 1946, we were fortunate in having Mr. H. S. Swingle of the Alabama Agricultural Experiment Station, Auburn, Alabama, inspect these ponds. He and others who have visited the Douglas area were surprised to learn of the potential fish productivity of this type of water. Those of us who at one time were prone to question different types of ponds as suitable habitat for bass and bluegills, now look upon all farm-pond waters with a more open mind.

HELPING HAND FOR FISHERY BIOLOGIST

During the investigations of salmon spawning areas in Deer Creek, a tributary of the Sacramento in California, members of the survey party had difficulty in keeping their shoes wearable from week to week. The Deer Creek flows through extremely rough, volcanic country, and basaltic rocks cut shoes to ribbons in a very short time.

One biologist (name withheld for obvious reasons), realizing during a patrol that his shoes would not hold together more than another day or so, decided to hike to the nearest town to buy a new pair. When he arrived in town after the 16-mile hike down the canyon, he looked more like a poverty-stricken knight of the road than a bona fide employee on the salmon investigations in connection with Shasta Dam. Dressed in his worn field clothes, his shoes tied to his feet with bits of rope, and his face sporting a 2-week growth of whiskers, the biologist was walking down the road leading to the only shoe store in the town when a well-dressed man driving in the opposite direction stopped alongside and held out a hand. Thinking that this motorist wanted to shake hands, the biologist put out his hand--and was given a two-bit piece. Hurriedly the biologist tried to explain. His benefactor cut short the explanation, waved his hand largely, and said as he drove off:

"Don't explain, my boy. That's all right. Go buy yourself a cup of coffee."

TROUT FISHERY IN OREGON

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OREGON HAS a population of only 12 persons to every square mile, but in spite of the sparsity of the population and the abundance of streams and lakes, the trout have been much reduced in recent years. Influences (other than overfishing) which have had their part in the decline include pollution, introductions of competitive species, and loss of fish through irrigation practices and the presence of barriers to migration. The trout in this State are the native cut-throats, the rainbow, the Dolly Varden, the lake or mackinaw, the introduced eastern brook, and the brown.

The cut-throat series contains a most diverse array of races of varied habits and appearance, and little is known of any of them. To add to the picture, in 1946 a race of isolated cut-throat trout was collected by the Game Commission in remote southeastern waters that have no outlet to the ocean. The presence of the fish had been known only to a handful of stockmen and fishermen. The trout is related to a cut-throat of the Lahontan Basin of Nevada and eastern California.

Anadromous and resident cut-throat are to be found in streams west of the summit of the Cascade Mountains. Resident fish tend to be in the headwaters. The anadromous and resident stocks of cut-throats in streams confined to the coast range and flowing westward to the ocean are inseparable systematically and are undifferentiated from resident stocks of the inland west-slope streams and lakes of the Cascades. The fish of the west-slope drainages do not vary significantly from the intermountain or Great Basin types in morphology, but in habits and sometimes in spotting and color they may differ, and intergradations of external appearance often occur. Certain isolated strains of the coastal forms which do not have access to the sea resemble the inland fish in external appearance more than their anadromous relatives. The cut-throats of coastal waters have not been successfully planted inland, and similar negative results are obtained when inland races are introduced into coastal drainage systems. Much effort is being directed toward learning more of the life history of the species in Oregon. Professor R. E. Dimick of Oregon State College has been responsible for much of our present knowledge of the cut-throats.

The Montana cut-throat of Yellowstone Lake has been introduced, and it does well in lakes at medium and high altitudes.

The coastal anadromous cut-throat has been the most abundant member of this group, but angling pressures and obstructions to fish migration have reduced the populations seriously. Regulations aimed at protection of the immature seaward migrants, reducing the bag limit and the length of season, have been placed in effect for 1947. A recent innovation has been the rearing of coastal cut-throat in hatcheries from "domestic" brood stock. In 1946 four such hatcheries produced nearly a half million trout, which weighed slightly more than 15 thousand pounds.

The rainbow trout furnishes most of the fish caught by Oregon anglers over the State as a whole, and the species is distributed throughout most of the streams and lakes. Nearly 46 tons of rainbows were released by the Game Commission in 1946. The runs of anadromous rainbows or steelhead have not suffered the disastrous reductions that have occurred in the salmon and the coastal cut-throat runs, but the populations are greatly diminished

from former years. Commercial fishing for steelhead trout has had much to do with the decrease. Recent legislation will endeavor to control all fishing for the species.

The main stocks of resident rainbows show little difference in appearance or habits, a condition which may be due in large part to the widespread scatter of plants of hatchery fish. Those differences which do occur are no more than might be expected in a series of fish from any one stream or lake. The larger rivers of Oregon provide a fair rate of angling success, but the small and easily accessible streams do not bear up under the fishing load of today. Most of the streams which originate in and flow westward from the Coast Range do not supply summer fishing for resident rainbows. In many of the Snake River tributaries, resident rainbows are found in abundance. Most of the streams are in canyons of great depth, canyons which are seldom visited by fishermen.

Except in small, cold headwaters where the fish provides some sport, the Dolly Varden trout is considered generally to be an unwanted predator, the flesh of which is usually less desirable than that of other salmonids. The elimination of the species in other waters is considered desirable but is practical only under conditions which make for ease in trapping the fish. Where the species inhabits a lake and runs into tributary streams, the adults may often be taken in weirs. At Wallowa Lake the Dolly is being trapped and removed as rapidly as possible as part of a plan aimed at the management of rainbow trout. No effort is being expended to perpetuate the Dolly in Oregon.

The lake trout or mackinaw is to be found in a few lakes, but it is rarely found in an angler's catch. Minnows may not be used as bait, and the attendant specialized tackle used successfully to prosecute the fishery is little known. Gill-net operations in the lakes known to contain the trout indicate that the populations are not large. Fish-cultural operations are not being carried on for this exotic species.

The eastern brook trout is found rarely in streams in Oregon, a contrast to its wide distribution in the rivers of its native habitat. Some of the streams at high altitudes and a very few lowland waters, usually spring-fed, provide habitat in which the fish is sometimes successful. Exceptionally large brook trout have resulted from placing the fish in virgin lakes at high altitudes in the Wallowa Mountains of eastern Oregon, but in nearly every instance the large fish have been replaced by much smaller ones after the lapse of a few years. Many of these lakes are accessible only by steep mountain trails, and the fish are capable of reproducing faster than the few fishermen can catch them. As a result, overcrowding has taken place and the food supply has suffered. During 1946 a fish-population study was conducted in 18 of the lakes: length at maturity and length-expectancy of catch were used to assess conditions within each lake. Some change in the stunted populations is expected as a result of cessation of fish planting and the inauguration of a year-around fishing season coupled with a bag limit increased to 30 fish a day.

It is a strange phenomenon that rainbow trout and stunted brook trout occur together in Long Lake in the Wallowa Mountains, yet the rainbow trout far outstrips the brook trout in growth and at maturity reaches a length more than double that of its eastern cousin.

The distribution of the brown trout is restricted for the most part to the Deschutes River system and to a few lakes in the adjacent mountains at its headwaters. Within the upper reaches of the Deschutes River the brown appears to be holding its own, and though the species is usually difficult to catch, it provides some sport. Two of Oregon's most productive lakes, Paulina and East, contain many large brown trout; but sportsmen are prejudiced strongly against the species because of the numbers of brook trout which reportedly fall prey to the browns. The brown is not caught so easily as other trout, but the sportsmen feel that the trout fishery has not reached a degree of prosecution which warrants the encouragement of the wary brown. In Oregon the species is not being propagated artificially to any extent.

As a result of their use as bait, minnows (Siphateles bicolor, Hesperoleucus

mitrulus, and Cyprinus carpio) have become established in some of Oregon's most productive rainbow and brook-trout lakes, and many of the lakes have been ruined by the subsequent reproduction of the minnows. It is now unlawful to transport cyprinids in the State or to use them in any waters except those known to contain bass. Where practical, poisoning operations have been carried on successfully, but there are some large lakes whose minnow populations cannot be eradicated under the conditions of our present knowledge of the problem.

All the species of trout are receiving increased attention aimed at maintenance and improvement, which are to be accomplished by regulation, salvage, removal of barriers to migrations, construction of fish screens at irrigation headgates, investigation of populations and their habitat, destruction of coarse fish, hatchery-disease control, and maximum hatchery production commensurate with good fish-cultural practices.

THE FISHERMAN

"Who's the stranger, Mother dear?
Look, he knows us, ain't he queer?"

"Hush, my own, don't talk so wild.
He's your father, dearest child."

"HE'S MY FATHER? No such thing!
Father died, away last spring."

"Father didn't die, you dub;
Father joined the fishing club.
But now the season's closed, so he
Has no place to go, you see.
No place left for him to roam:
That is why he's coming home.
Kiss him--he won't bite you, child.
All those fishing guys look wild."

(Anglers News. February 1947)

FARM PONDS—Real and Potential Values

William H. Thompson
Game and Fish Commission
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The real value of a farm pond is its share in a soil and water conservation unit. The owner's interest in clear water may lead to watershed improvements. The potential value of the fish production of the ordinary farm pond has been overrated. The stocking ratio is not the answer to the problem of overpopulations. One or two warm-water species readily dominate and overpopulate small bodies of water. The reproductive potential of the fishes introduced and the habitat available are the primary factors involved. For best utilization of the farm pond, the fishes best suited to the individual pond must be stocked and the fish crop must be harvested annually like any other farm crop.

THE YEAR 1947 finds the average American going fishing. Everyone seems to be getting the bug. It is not an uncommon thing to see a crowd of anglers trying to cast their lines in the same small pool: each is as eager as the next to catch his limit--or even to catch something. This increasing demand puts the propagation man and the technician on the spot. We are confronted with that ever present question, "Why can't I catch some fish?"

The situation is aggravated by the fact that many of our once beautiful streams are now laden with silt and pollution. Industrial plants are belching black, smelly wastes into the waters. Our grass lands that should have remained grass lands have come under the plow. In general, our streams have caught the full fury of man's exploitation. The fish house has been destroyed, and the fish species have disappeared one after another. In too many waters only the more civilization-resistant species remain.

Many of our old lakes have deteriorated to the point where their usefulness to the angler is practically nil. Most attempts to rejuvenate those lakes have met with little or no lasting success. Even when they are drained and restocked with myriads of combinations and ratios of game fishes, these lakes tend to revert to the same old conditions in a short time. New man-made lakes perhaps have given more success than any one thing. Many of them, however, are deteriorating as they grow older.

During the last few years thousands of farm ponds have been built, and these have come in for their share of attention. Farm-pond builders have been extremely interested in and optimistic about the potential values of these ponds as fish producers. Conservation workers have stood ready to take up the cry. Biologists have swarmed over these ponds as hatcherymen dumped in thousands of fingerlings.

To the average sportsman, planting fish is the solution to all problems. Now we are meeting this demand to stock and restock. We christen a new farm pond with bass, bream, crappie, and channel catfish and without a quiver proclaim the lowly pond a lady. If there exists any uncertainty of success, we cast it aside with the explanation that she needs only the proper management.

Actually, are we now satisfied that the many thousands of farm ponds will supply so many thousands of acres of fishing waters? Have we been able to manage

small bodies of water so that they fill the needs of sports fishing? Let's not plant fish and advise a man to spend hundreds of dollars in fertilizing, planting, and similar activities until we are sure of success. If we are still experimenting, why not conduct our work on a smaller scale and in private until we learn the answers? We should, by all means, consider the effects of possible crop failures in the ponds. We need the farm-pond owner's future interest and confidence in order that we may build for better game and fish conditions.

No one denies the real value of a good farm pond. One does not need to be a supersalesman to sell a good farmer on the idea. The pond is a water reservoir and, if located in a gully, may also serve as a means of erosion control. Soils that cannot be held during flash rains can be stopped by a pond. It is at least some satisfaction for the man on the farm to realize that his soils are not being carried downstream. Some people are farsighted enough to visualize the day when these pond-trapped soils may be retrieved and used again to grow corn. Very often the farmer does not like muddy waters, so he takes it upon himself to do something about it. Terracing and other watershed improvements follow, and soon his whole farm may be thus protected. Then, for the farmer, the farm pond has had a value that far exceeds that of water supply. But that isn't all. Sportsmen may be able to reap part of the harvest. Fertile watersheds provide fertile conditions for game. The fish man knows too well that the decline of fish in most of our streams can be attributed to silt and pollutions that can be controlled largely by terracing the uplands and by constructing farm ponds. These represent the real values of farm ponds and should be recognized ahead of all others.

If farm ponds have possibilities as sports and fish producers, they should by all means be exploited. A hundred thousand acres of pond waters is something to think about. If Nature's rules and regulations permit the continuous production of bass, bream, crappie, and channel catfish, we are ready to sit up and take notice.

Sadly enough, in spite of the pressing need and the desire to aid the anglers, we are inclined to become at least conservative on this score. The records show that most sportsmen who buy fishing licenses cast their lines almost entirely in waters other than farm ponds. Whenever a State acquires large artificial lakes, there is a noticeable jump in license sales. This is hardly the case when thousands of farm ponds are built in the same State.

Biologists who have occasion to dig into the farm-pond fish populations find, many times, situations which are not conducive to good sports fishing. Small ponds with populations greatly out of balance are the common thing. One or two species dominate, even to the extent of overpopulation. Overpopulation means a stunted population. Strangely enough, even bass are stunted when the pond has become overpopulated with forage fish. The over-all population in pounds per acre may be ample. The pond may support so many hundred pounds per acre, but 90 percent of the weight is probably made up of fish of sardine size. Since all upstanding sportsmen are definitely not interested in sardines, we immediately rule out fish populations of this sort. Why crappie are chosen to dominate in certain ponds, while carp, orange-spotted sunfish, green sunfish, bullheads, or flat-headed catfish dominate in others, is still an unanswered question. The fact is that they do. Is it competition between the fishes themselves, or is it primarily a result of soil and water conditions that fit the requirements of certain species? It may be a combination, but the latter seems to be the better explanation. We seem to be making some progress in our classification of these conditions. In Oklahoma we recognize certain muddy waters as being predominantly crappie waters, while we designate other, very shallow and silted rich waters as carp and flat-headed catfish waters, and so on. This classification is by no means complete or infallible, but it shows promise. Perhaps we have overpopulation because the waters provide only one major type of soil and water conditions. That overpopulation and stunting usually do

not occur in most large lakes except as temporary seasonal phenomena, may be attributed to the diversity of the environmental areas. This variety of conditions may be necessary for the maintenance of a balance of a group of species which are themselves quite specialized in their requirements. If we could then classify a farm pond and plant and foster the fish designated by the classification, could the farm pond still be made into a sports fishing area? The answer is yes, if we accept the species that thrive best in the pond and if we are willing to harvest the annual crop as any other crop should be harvested. The trouble is that most of us insist on producing certain game species in waters that may fit only some rough species. Game species planted in carp waters are disappointments to the owners and headaches for the conservation man. It does not matter much to Nature what ratio of the bass-bluegill combination is employed: if the waters happen to be bluegill waters, bluegills will eventually rule the roost. In 99 percent of the ponds, ordinary hook-and-line fishing pressure can likewise be ruled out as a factor which influences species composition. How many times have we seen farm ponds completely ignore some theoretical ratio, say 50 bass to 500 bream? It is a common thing, too, to find 6 months later that some pesky pumpkinseed has slipped in and stolen the show. So it seems that all waters do not have the same ailment. A chronic case of "carpitis" cannot be cured with a pill which has as its constituents 50 bass and 500 bream. If we want fish in certain waters, let's find out what species we need and concentrate on them.

Some workers have advocated the application of fertilizers to pond waters to relieve a condition of overpopulation. The theory behind this argument is that stunted fish are stunted because the food available is not ample to support the big population. Fertilized waters do produce more small food animals and plants. The hatcheryman will probably agree that more pounds of fingerlings per acre can be produced in a fertilized pond. If that same crop of fingerlings is harvested, another similar crop can be produced the next year. But here we are speaking of a harvestable crop. Farm-pond yields are not harvested to any great extent. The same crop is held over year after year. Fertilizers may actually aggravate overpopulation by creating more food so that a greater percentage of the new-born can survive.

Do we actually need to fertilize a farm pond? As a rule, most of our ponds that are more than 2 years old are already fertile enough. They should be if they are recipients of waters from a fertile watershed. Fertilizers do not seem to be the answer to the problems. As a rule, any extra fertilizer can best be used on the watershed to improve its vegetative cover.

All naturalists will appreciate the enormous reproductive capacity of living forms. Even the human populations go beyond the number that can live off the land. If it were not for diseases, accidents, and wars, human overpopulation would catch every nation.

In view of this, fish can most certainly be expected to overpopulate if they are not checked. The reproductive potentials of fish are indeed great. One pair of fish and their offspring will produce billions of eggs in a very few years. Nature has been generous with the eggs. She has made allowances for the toll taken by diseases, predaceous enemies, and unfavorable conditions. In a large lake, large catfish, gars, turtles, alligators, and even suckers make war on our game fishes. This is important as another of Nature's checks on the various species. In small farm ponds, our exclusion of the big bad wolves probably contributes also to a condition which leads to the production of too many fish.

In the future let's keep our feet on the ground. Give the farm pond a fair trial, but refrain from overrating it. Above all, remember that producing fish for meat and for sport are two different things. If we are to insist that game fish be grown in all our waters for sporting purposes, it will be necessary to harvest the fish like any other crop. Unless we make provisions to harvest the fish crop at regular intervals, we may be disappointed.

Gallatin River, Montana, where grayling were stocked.
(Pictures courtesy of Mr. Tryon.)

THE MONTANA GRAYLING

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Montana grayling are now found, with few exceptions, only in the headwaters of the Big Hole River, Montana, and in lakes of that region. Despite their restricted distribution, the grayling make spirited spawning runs from these waters into various small inlets. Cultural operations have been successful in maintaining good populations in waters still frequented by grayling. Though apparently suitable spawning grounds are present in the West Gallatin, stocking must be continued to maintain satisfactory fishery under the present fishing pressure.

ALL GRAYLING of the world belong to a single genus, Thymallus, which has a ringlike distribution around the arctic regions, a distribution similar to that of the whitefish and chars although at present much more localized. In the continental United States only one species of grayling occurs. This species, Thymallus signifer, occurs most abundantly in Alaska and northwestern Canada and in historic times has occurred in the United States in Montana and Michigan. Jordan (1905) felt that these two colonies were remnants of a postglacial fauna which had extended further to the south, and that they were tending to extinction. Since then the Michigan stock has disappeared and the Michigan waters have been restocked with grayling from Montana.

When white men first came to Montana,

See also:

Johnson, H. E.
1937. Feeding Montana grayling fry. Prog. Fish-Cult. 30: 35-36.

grayling occupied the headwaters of the Missouri River, chiefly in the Jefferson, Madison, Gallatin, Smith, and Sun Rivers. It will be noticed that all these streams are above Great Falls, the first major barrier as the Missouri is descended. Isolated in this region, the Montana grayling developed differences from the arctic grayling in length of life, age of maturity, and growth rate, as shown by the work of Brown (1943) and Miller (1946).

At present the distribution of Montana grayling is much reduced, and these fish are found, with few exceptions, only in the headwaters of the Big Hole River and in the lakes of that region. About 3 million eggs are taken annually by the State, according to Mr. A. G. Stubblefield, the Superintendent of State Fisheries; by means of these a good population is maintained in the few waters still frequented by grayling. The rapid reduction in the numbers of grayling in the last 60 years is believed by Brown (1943) to be due to competition from introduced species of trout although the grayling is apparently compatible with the cut-throat trout native to these waters.

The present writer is inclined to feel that, though the grayling is a good game fish, it is by no means so wary a fish as any of the trout. As a result, in streams containing both grayling and trout, the grayling take the brunt of the fishing pressure, which is maintained (owing to the presence of trout) until there are not enough grayling left to continue to propagate themselves.

Spawning Habits

Early accounts of grayling in Montana mention long spawning migrations, some many miles in length. Henshall (1907) believed that they traveled from the Jefferson River far into the headwaters. Brown (1938) does not consider this likely; he believes the grayling is more limited in its runs. Many of the old residents of this region tell of great runs up the Madison River and speak of the river as being carpeted with fish from bank to bank. The present restricted distribution, confined mostly to the lakes, makes such runs a thing of the past.

The grayling does show a spirited spawning run from lakes into various small inlet waters, and its spawning actions excel those of the trout in interest and beauty. Brown (1938) has described these activities as they occurred in the inlet to Agnes Lake in Beaverhead County. In the inlet to Rogers Lake in Lake County their activities were found to be much the same although opportunity for observation was a little greater.

In 1939 grayling were found in the inlet, a small temporary stream made by melting snows, its flow about 1 cubic foot a second. Traps and a small impassable dam were located one or two hundred feet above the lake. When stripped, the fish were thrown upstream above the dam. As they were first observed at 11 a.m. on May 6, the grayling in the stream were drifting back toward the lake as far as possible, those below the dam going on down and out of the stream. The water temperature was constant at 40° F. throughout the time of observation.

At 3 p.m. the fish still left in the stream started to move back up and intermittent spawning acts occurred. The fish were polygamous and apparently made no attempt at nest-building. A male would take up a favored location over a quiet portion of the stream where the bottom was sandy and would maintain his position against other males that attempted to enter. Though they simulated the pugnacity of trout, no great damage was ever done and usually the smaller male was shouldered out of the bed.

When the females came by, the males attempted to spawn with them. The male pressed against a female, erecting the large dorsal fin over the female's back. If the female responded by returning the pressure, their dorsals would be applied tightly, the anterior dorsal portions curving over the female and the caudal portions over the male. The sex products were emitted, apparently simultaneously, while the fish were side by side and quivering violently. The spawning act lasted for 10 seconds, during the latter part of which the tail movements stirred up a cloud of sand so that the eggs could not be seen. The female was usually exhausted and would sink to the bottom with wide-open mouth and lie on her side. The male

Grayling nesting in water so shallow that the dorsal fin and part of the back are out of the water. Inlet to Rogers Lake.

recovered more readily. In the course of 1 minute one male spawned with four different females on their way upstream. The same spot or bed was used many times by the same and different pairs.

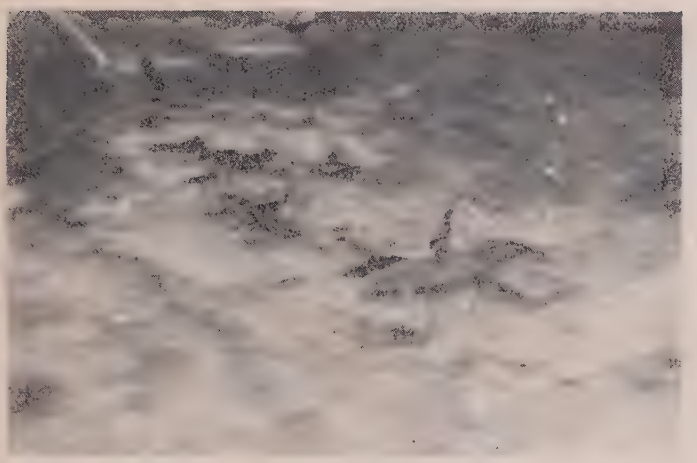
Between 5 and 6 p.m. grayling began to run from the lake into the stream. Schools of grayling could be seen lying about 30 feet out in the lake. The shoal water close to shore apparently acted as a barrier. Small groups of four or five grayling would detach themselves from a school and would come shooting toward the stream, only to turn and dash back as the water shoaled. By 7 p.m., as it began to grow darker, these small groups did not stop but went up the stream in one swift, battering rush. By 8 p.m. there was a constant procession of schools of 15 or 20 making the dash from lake to stream.

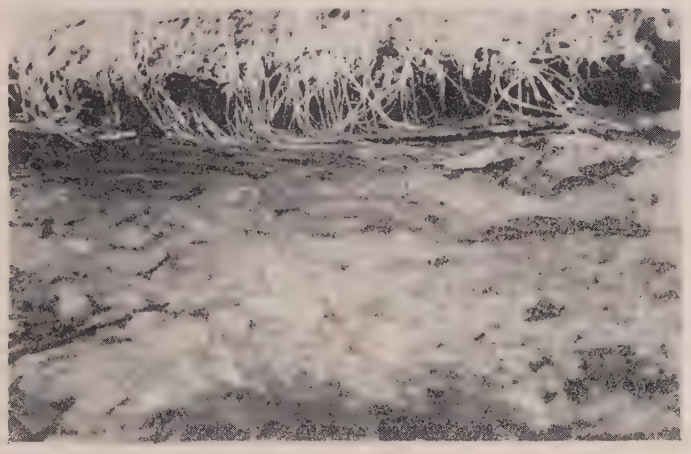
The stream at its entrance to the lake was not more than 2 or 3 feet wide, and for 50 feet or more it was one continuous fast riffle. The numbers of grayling were such that the stream was filled with fish packed in side by side from bank to bank. The water was so shallow that the great dorsals and even part of their backs were out of water, yet they contrived to ascend the stream steadily. As they reached the quieter portions, they spawned as opportunity occurred although most of the females were still green. They rested in either the riffles or pools by lying on the bottom. If one fish came by from below while a group rested, they would all start to rush up the stream again.

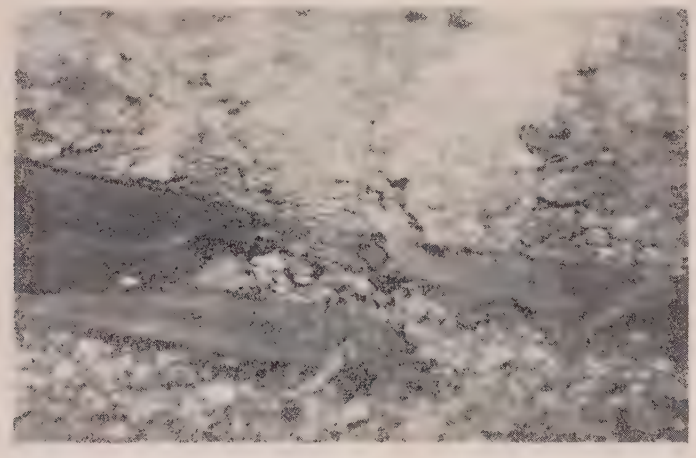
By 10:30 p.m. the run began to slow down although fish were still coming from the lake, and by 11 p.m. there was a definite slackening. At 6 a.m. the following day the stream was practically empty; all the fish were down as far as they could get.

It is not possible to say what stimulus initiates an individual run or what stops it. Most of the spawning runs occurred in water close to 50° F. although in a few instances, as above, the temperature of the inlet was as low as 40° F.

All the spawning observed was on sandy bottom, where the rush of water was quieter. Other observers have noted grayling spawning on gravel or even along the shore of a lake. The inlets to lakes where grayling have been observed in Montana may or may not be natural spawning grounds; in each case, they were the only spawning streams available. At one time the grayling in Georgetown Lake spawned in Blodget Inlet and traps were set there for spawn-taking. In later years the run shifted to Flint Creek Inlet, where some spawn is still taken although the run has greatly decreased. The reason for this is not known: the only discernible difference is







SPAWNING IN INLET TO ROGERS LAKE

Male, beside female, erects dorsal fin.

Type of bottom ordinarily used in spawning.

Grayling on spawning bed that contains much more gravel than usual.

that Flint Inlet runs about 5° warmer than Blodget.

The only suspicion of a natural run in Montana was one reported by Mr. Park Taylor, a rancher, on the west fork of the Gallatin River. In the first part of April 1941 he reported numerous small grayling running in the lower part of the Buffalo Horn Creek, a tributary of the Gallatin River. This stream is 5 to 12 feet wide and has a rocky bottom and fairly good pools. When the stream was visited on April 19, 1941, most of the grayling were gone. The water of the Buffalo Horn then was 32° while that of the Gallatin River was 46° F. No evidence of actual spawning was obtained. If this represented a run, it was unusually early and was accomplished when the water temperatures were much colder than during the runs from lakes.

Culture

Henshall (1907) gives the earliest accounts of attempts to culture grayling in Montana. Eggs and milt are stripped from grayling in the same fashion as from trout and about as readily although there is some difficulty in obtaining sufficient quantities of milt from the males. When taken, the eggs are amber in color and about 0.095 inches in diameter. They require 2 hours to water-harden and then are 0.15 inches in diameter.

Once impregnated, the eggs, which are adhesive, are placed in jars until eyed, when they may be placed in trays. The development from impregnation of the eggs until advanced fry is given in table 1. These eggs were taken from Grebe Lake in Yellowstone Park on June 11, 1938, and cultured at the Bozeman hatchery.

In hatcheries, as Brown (1939) has demonstrated, the fry start to feed on about the fifth day. Originally considerable difficulty was experienced in feeding the advanced fry, but the work of Laird (1928), Lord (1932), and especially Fuqua (1939) has shown that this may be overcome by providing food of particle size. Fuqua also gives other pertinent information on the raising of grayling.

In table 2 are given growth data on grayling kept for the most part in the Bozeman hatchery. Two lots of eggs are involved, one taken in 1937 and the other in 1939. Both lots of eggs came from Grebe Lake in Yellowstone National Park. The 1939 eggs, which furnished the data for the earlier stages, were kept at a slightly higher temperature as indicated.

Brown (1943) and Miller (1946) have given data on the growth of wild grayling.

Stocking

The West Gallatin is one of the three main headwaters of the Missouri River and is an excellent trout stream throughout. Temperatures are good, and food is abundant. Coincident with the successful culture of grayling at the Bozeman hatchery, the upper waters of the West Gallatin were stocked according to the figures given in table 3. These waters already contained good populations of rainbow and cut-throat trout.

All these fish were stocked in the upper 20 miles of the river. This heavy stocking was very successful: anglers began to catch grayling in 1939, and by 1940 and 1941 good grayling fishing was possible. By 1942, 12- and 14-inch grayling were being caught and dude ranchers reported catches of 2- to 3-pound grayling. Even though the latter reports may be exaggerated, they do indicate that a successful fishery had been established by stocking.

With the advent of the war stocking of grayling in the Gallatin was abandoned. The effects could be noticed the following year, and by 1945 and 1946 grayling were no longer being caught. Many small tributaries, apparently suitable spawning grounds, are available to grayling in the Gallatin watershed.

In the spring of 1938, Squaw Creek, a tributary of the Gallatin, was stocked with 5,000 5-inch grayling. One thousand of these were tagged, but only three tagged fish were recovered--all from below the mouth of the Squaw in the Gallatin River. Attempts to census the Squaw revealed only trout present. Apparently, by the fall after the stocking, all grayling had left Squaw Creek except in some beaver ponds near the mouth. Squaw Creek is a rapidly flowing stream about 10 to

TABLE 1.--Development of grayling eggs and fry

Stage	Number of days	Temperature units	Mean daily temperature	Losses	
				Number	Percent
Impregnation to eyed	10	154.1	47.2° F.	4,800	3.83
To hatching	23	291.9	48.3	7,050	5.64
To advanced fry	1½	27.	50.	1,875	1.5

TABLE 2.--Development of grayling fingerlings

Group	Number of days from hatch	Weight	Length
		(ounces)	(inches)
1939 eggs held at 55 degrees	18	0.0098	
	51	.0152	
	83	.0388	
	113	.0734	
	143	.0995	
	174	.1154	
	205	.1546	
	236	.2026	
1937 eggs held at 50 degrees	223	.0826	2.49
	286	.4165	4.40
	322	.4977	4.45
	334	.5852	4.88
	[1]522	2.1852	7.05
	[1]813	2.7876	9.37

[1]These fish were kept at Ennis hatchery during later stages.

15 feet wide and averages 9 cubic feet of water per second. The bottom is rock and rubble, and pools are shallow and limited. Food is good except for occasional periods of silting during or after high water. Such a stream is evidently not desirable for 5-inch grayling.

The following conclusions could perhaps be drawn from this experience with grayling stocking:

1. Grayling are capable of growing from small to large size in appreciable numbers in the Gallatin.

2. Stocking in such a stream can provide a grayling fishery sufficient to satisfy anglers, but stocking must be maintained or the fishery will fail even though there are apparently suitable spawning grounds.

3. It is possible that grayling, occupying much the same ecological niche as trout, are substituted for trout in the fish population of the stream.

It might be said that there are interesting possibilities in the grayling as an indicator fish in stocking or even as a buffer species in aquatic management.

TABLE 3.--Stocking of grayling in the West Gallatin

Size	Number stocked in year			
	1938	1939	1940	1941
2-inch	19,800			
3-inch		7,000		
4-inch	1,131			10,600
5-inch	5,000	38,800	17,000	13,750
6-inch			14,600	

Acknowledgments

Acknowledgments for help are due to Mr. Charles Fuqua of the Fish and Wildlife Service, and the late Mr. M. H. Spaulding of Montana State College.

Literature Cited

Brown, C. J. D.
1938. Observations on the life history and breeding habits of Montana grayling. Copeia 1938 (3): 132-136.

1943. Age and growth of Montana grayling. Jour. Wild. Mgt. 7 (4): 353-364.

------ and Buck, Charles, Jr.
1939. When do trout and grayling fry begin to take food? Jour. Wild. Mgt. 3 (2): 134-140.

Fuqua, C. L.
1939. Feeding of Montana grayling at the Bozeman, Montana, station. Prog. Fish-Cult. 43: 12-17.

Henshall, J. A.
1907. Culture of the Montana grayling. Bur. Fish. Doc. 628: 1-7.

Jordan, D. S.
1905. Guide to the study of fishes. Volume 2. Henry Holt, New York.

Laird, J. A.
1928. Grayling in the east. Trans. Amer. Fish. Soc. 58: 167-169.

Lord, R. F.
1932. Notes on Montana grayling at the Pittsford, Vermont, experimental trout hatchery. Trans. Amer. Fish. Soc. 62: 171-178.

Miller, R. B.
1946. Notes on the arctic grayling, Thymallus signifer Richardson, from Great Bear Lake. Copeia 1946 (4): 227-236.

HAVE YOU NOTICED ANY MALLARD DUCK RAIDS UPON THE FISH POND?

Mallard ducks, it was recalled, had begun coming into the vicinity about January 10. Further, the birds had been most abundant in the neighborhood of the pond in the week from February 3 to February 10. Hatcherymen had paid little attention to these birds, however, because mallard ducks had never previously caused any loss at this station. Apparently, these were first-time offenders.

On January 3, 1947, approximately 40,000 4- to 5-inch Montana grayling were weighed and checked in a 15- by 120-foot dirt pond at the U. S. Fish-Cultural Station, Ennis, Montana. The pond was cleaned each week. No particular shortage of grayling was noticed when the pond was cleaned on February 3, but on February 10 it was found that the pond contained only about 1,000 grayling.

THE CONTROL OF AQUATIC PLANTS WITH PHENOXYACETIC COMPOUNDS

EXPERIMENTAL WORK WITH CERTAIN PLANT-GROWTH REGULATORS AS HERBICIDES

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and

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DURING THE WAR a number of new compounds called "hormones" or plant-growth regulators have been developed, particularly in the laboratories of the Chemical Corps at Camp Detrick, Maryland. Several hundred new compounds were synthesized and their effects on plants tested. Results of many tests made at Camp Detrick were reported in Botanical Gazette (volume 107, June 1946). Some of these plant-growth regulators have been tested as herbicides on obnoxious aquatic plants at the Fisheries Experimental Station, Leetown, West Virginia, during the 1946 season, with the advice and collaboration of personnel from Camp Detrick.[1/]

It has been found possible to control such highly obnoxious emergent plants as the cattail, spikerush, soft-stem bulrush, burreed, willow, pondweeds (Potamogeton crispus, P. nodosus, P. filiformis), and the American waterweed (Anacharis canadensis). The results with the water lily are not yet known.

At present it appears that eradication of water lilies, cattails, and soft-stem bulrushes cannot be effected under all conditions by a single spraying. Thus, a 5-percent solution of 2,4-D in tributylphosphate in kerosene, and a 1-percent solution of the ethyl ester of 2,4-D in kerosene, sprayed on separate beds of cattails on July 31, 1946 (before the plants flowered), killed underground stems and aboveground parts of the plants. At Moorefield, West Virginia, large beds of cattails in drained ponds were sprayed on October 1, 1946, with 2,4-D in both triethanolamine and tributylphosphate, and all plants were killed above ground where the tributylphosphate mixture was used; but examination of the pond bottoms on April 4, 1947, revealed that apparently viable shoots were developing underground where the soil was of a clay texture and rather dry. In an adjacent pond that had wet, limy soil, there were fewer viable shoots. Bauman (1947) has already described the action of the butyl ester of 2,4-D in weakening plants so that bacteria and fungi may destroy the underground rhizomes.

1/The aid, advice, and encouragement received in this project from Dr. A. G. Norman, Camp Detrick, are gratefully acknowledged.

Dr. S. F. Snieszko of the Leetown staff served at Camp Detrick during the war and suggested this cooperative work. He has aided in this project with color photography.

The surface leaves of the water lily (Nymphaea) were sprayed with a 5-percent solution of 2,4-D in tributylphosphate and kerosene, or with a 1-percent ethyl ester of 2,4-D in kerosene, July 31, 1946. The surface leaves curled and the petioles became spirally twisted, but the plants later recovered. After this recovery, the pond was drained and the leaves and petioles were sprayed again with a 5-percent solution of 2,4-D in tributylphosphate and kerosene. An inspection of the treated beds on April 8, 1947, showed few new shoots except in the control area, where many new shoots had already risen to a height of 4 inches or more.

Though emergent stems were killed, small patches of soft-stem bulrush have produced new shoots. It is obvious that at least an additional spraying will be necessary for eradication.

On the other hand, eradication of the burreed was effected in an area sprayed September 8, 1946.

For the hatcherymen, spraying with 2,4-D has many advantages over controlled cutting, which has been found laborious and sometimes ineffective. The 2,4-D formulas suggested in this article are immediate in their effects. The erect stems of the cattails are brown within 2 to 7 days after spraying.

Observations over a considerable period of time will be required to determine when applications of 2,4-D in ponds will be most effective for eradication as well as control.

The emergent plants can be sprayed most effectively with aqueous or oil solutions of 2,4-dichlorophenoxyacetic acid (2,4-D). The submerged plants can be controlled by spraying the pond surfaces with solutions containing 2,4-D, and by draining the pond and spraying the bottom with similar solutions.

Aqueous sprays have been less effective than oil sprays. In the preparation of oil sprays, however, tributylphosphate (Ennis, Thompson, and Smith, 1946) is employed as a cosolvent in order to introduce 2,4-D into the oil. Any low-viscosity oil that is light enough to be sprayed can be employed, but care must be exercised in the use of such tributylphosphate-oil sprays because of the high toxicity of tributylphosphate to fish. Concentrations of this compound in excess of 15 p.p.m. are toxic to bluegill sunfish. Action frequently is very rapid. Esters of 2,4-D that are directly miscible with oil can be employed, but these are not so readily available as 2,4-D itself.

In the spray solutions employed in large-scale investigations, concentrations of 2,4-D ranged from 15 to 1 percent in both kerosene and water, in which tributylphosphate and triethanolamine, respectively, were used as cosolvents.

Attempts to control submerged vegetation by adding pellets of 2,4-D at the rate of 10 pounds per acre to filled ponds did not prove wholly satisfactory. This method is being studied further, however, in view of the simplicity of the operation.

In aquarium experiments, 2,4-D, 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and 2-methyl-4-chlorophenoxyacetic acid have been found very effective on Anacharis canadensis and Potamogeton crispus at the level of 10 p.p.m. At 5 p.p.m., 2,4-D killed Anacharis. With 2,4-D at the 2.5-p.p.m. level, abnormal development of terminal buds and increased brittleness occurred in the stems, but the rate failed to kill. In these experiments Chara was unaffected. At a 10-p.p.m. level, ammonium sulphamate and O-isopropyl N-phenyl carbamate arrested growth but did not kill the plants.

Experience has shown that concentrations which have been effective in aquaria have been less effective in ponds. This is due, no doubt, to loss of the compound through such factors as seepage, adsorption, and microbial decomposition. In order to obtain the same degree of control in ponds as in aquaria, higher concentrations of these chemicals must be employed.

EMERGENT PLANTS

Cattail (Typha latifolia)

The cattail is probably the most common obnoxious emergent aquatic plant about pond stations. Ditches invariably become clogged with cattail. Once it becomes established in a pond, this weed quickly reduces the area capable of producing fish. At the Moorefield, West Virginia,

substation it is estimated that cattails in two of the four ponds have reduced the productive pond-surface area by 25 to 30 percent per pond within 3 years.

When only a few plants are present in a pond, they may easily be pulled up by hand. This plant has an underground stem or rhizome from which new shoots arise at the joints (nodes). These rhizomes are rather brittle and often break off when efforts are made to pull them up by hand. The broken-off sections are capable of producing new shoots; so even though the hatcheryman superficially removes all plants, new shoots almost invariably arise the next season.

Controlled cutting of the cattails has been practiced, particularly in Europe, for many years, but this method is laborious, especially where the cattails have become well established.

In the experiments at Moorefield and Leetown, 2,4-D with tributylphosphate as a cosolvent and kerosene as carrier proved the most effective treatment. Tributylphosphate, in itself, has considerable value as a herbicide and greatly facilitates the penetration of 2,4-D (Special Projects Division, Chemical Warfare Service, 1946b).

Apparently, if the plants are to be eradicated by a single spraying, they should be sprayed before they produce flowering spikes.

This spray material can be applied very effectively with a knapsack sprayer, which will deliver fine spray at about 40 pounds of pressure per square inch. An important advantage of this spray solution is the glistening oil-soaked appearance it imparts to treated plants, a condition that enables the operator to see exactly where he has sprayed. This oil-soaked appearance is caused by rapid penetration of the carrier. Within 2 days after the treatment, plants become bleached (figure 1) and sprayed portions of plants appear to be dead. About 20 gallons of the spray per acre are required where cattails have already become well established.

At the Moorefield substation, one-tenth of an acre of cattails was sprayed within a 15-minute period with a knapsack sprayer and a 5-percent 2,4-D solution in kerosene and tributylphosphate as described below.

Another effective formula used for the treatment of cattails at the Moorefield substation during the 1946 season was a 7.5-percent aqueous solution of 2,4-D with triethanolamine as cosolvent. In large-scale applications of this formula, as well as all other aqueous solutions, it is difficult to determine just what part of a dense growth of weeds has been sprayed. The aqueous solutions do not glisten upon the leaves of the cattails as do the oil sprays.

This disadvantage can be overcome in part by adding a water-soluble dye to the aqueous solution. Suitable dyes are anthraquinone blue and ceresine, which should be used at a concentration of about 1 percent.

Failure to cover the cattails adequately during the first spraying necessitates further spraying and subsequent loss of time. The wetting of cattails, followed immediately by a dusting with 2,4-D powder containing 50 percent 2,4-dichlorophenoxyacetic acid, proved ineffective.

Spikerush (Eleocharis)

This plant, of which there are many species, forms a lush green mat (seldom more than 6 inches high) on the bottom of ponds. In the ponds at Leetown the weed usually begins its growth in the fall after the ponds have been drained. Spikerush thrives best in ponds which do not become thoroughly dried out. It is very difficult to remove fish from a pond that has a growth of this weed[2/] on the bottom. The plant cannot be raked, and the growth is not tall enough to cut. Small fish such as bluegill sunfish and bass find shelter in it and refuse to leave even when the water reaches a low stage.

Efforts to control by spraying with sodium arsenite and copper sulfate when the plants were submerged had proved ineffective.

At the New Jersey State Fish Hatchery at Hackettstown, this plant (or a closely related species) is removed manually with a fire hose and high-pressure nozzle.

2/Mr. F. M. Uhler of the Patuxent Research Refuge, Bowie, Maryland, identified this as Eleocharis acicularis.

At the Tresselt Fisheries, Thurmont, Maryland, where spikerush became established in some ponds, the only effective method of elimination was by plowing the turf under. Efforts there to control it by heavy fertilization failed.

In experiments at Leetown, this weed has proved quite sensitive to the 2,4-D formulas used.

Round-stem Bulrush (Scirpus validus)

The round- or soft-stem bulrush is another common nuisance at hatcheries. It becomes much more solidly rooted than cattails in a pond bottom. The underground stems are thickly matted and almost impossible to pull by hand.

Fifteen percent 2,4-D in triethanolamine and water and 5 percent 2,4-D in tributylphosphate proved very effective in killing this weed down to its roots. Figures 2 and 3 show untreated and treated clumps, respectively.

An inspection of weed beds on April 7, 1947, revealed new shoots arising from the rhizomes of the plants, the above-water portions of which were destroyed with 2,4-D on September 8, 1946. At the present time it appears that more than a single application will be required to eradicate this weed.

Burreed (Sparganium americanum)

Burreed is common in ditches where water flows continuously. The plant will establish itself about the borders of small lakes and large ponds which have a fairly constant water level. Although it is common about the station grounds at Leetown, burreed has not become established in any pond which is drained every year.

Fifteen percent 2,4-D in triethanolamine and water was very effective in controlling burreed (figure 4). The tributylphosphate-kerosene formula would probably be even more effective. In an experiment where the plants were wetted first and dusted immediately afterwards with 2,4-D powder containing 50 percent 2,4-D, the plants were not seriously affected.

Eradication of this species appears to have been effected by a single treatment in the experimental plot at Leetown.

Willow (Salix)

The willow is notorious for its destructiveness to pipe lines. At Leetown, in spite of efforts to control it by removal of the entire tree or shrub with power equipment, willow has persisted and obtained a foothold in numerous ponds at the station. The spraying of the trees or shrubs with 2,4-D in tributylphosphate and kerosene will provide a quick and easy means of control.

SUBMERGED PLANTS

Anacharis canadensis

This weed is among the most objectionable because of its many means of propagation. The fragile stems fragment easily when raked. It is almost impossible to rake Anacharis effectively unless the beds have become so dense that the weed is on the point of shading itself out. Ordinarily it must be cut with scythes before it can be forked into piles.

Each fragment of the stem is capable of growing into a new plant. Adventitious roots appear readily at the nodes, and fragments that reach the bottom become rooted quickly. Terminal buds are usually present at the tip of each stem. These buds readily break from the stem and develop into new plants. This weed also has underground stems from which new shoots arise. To add to the difficulties, waterweed produces flowers and seeds.

In aquarium experiments, this plant has been killed readily by treatment with 10 p.p.m. of 2,4-D; 2,4,5-T, 2-methyl-4-chlorophenoxyacetic acid, and 5 p.p.m. of 2,4-D were also effective. The phenoxyacetic compounds were more effective than ammonium sulphamate on Anacharis canadensis and Potamogeton crispus. Ammonium sulphamate definitely arrested the growth of these species. In large-scale experiments, however, 2,4-D applications at 10

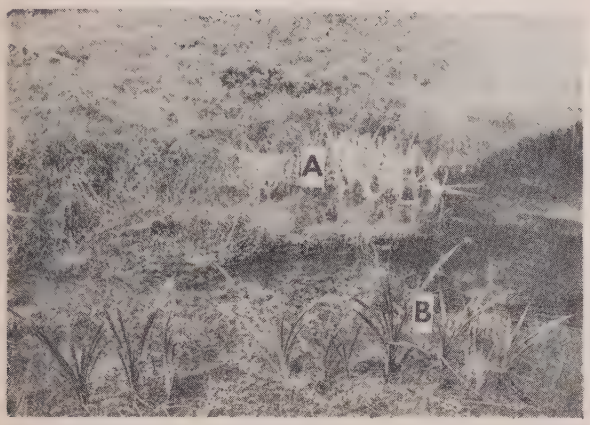

Figure 1.--(A) Young cattail patch 2 days after spraying with 1 percent ethyl, 2,4-dichlorophenoxyacetate. No recovery. (B) Unsprayed patch.

Figure 2.--In foreground, untreated round-stem bulrushes. In background, treated bulrushes shown in Figure 3.

Figure 3.--Round-stem bulrushes treated with 15 percent 2,4-D in triethanolamine and water.

Figure 4.--(A) Burreed sprayed with 15 percent 2,4-D in triethanolamine and water. (B) Unsprayed burreed.

pounds per acre thus far have succeeded only in arresting growth in some ponds. Figures 5 and 6 show the effects of 2,4-D on Anacharis canadensis.

In this species, the effects of 2,4-D are manifested by a greatly accelerated growth of the terminal buds, which are soon separated from the stems. The latter become black and constricted before death. The leaves remain green and are retained by the stems for a considerable period.

Potamogeton

Applications of 2,4-D in tributylphosphate gave adequate control of broad-leafed pondweed (Potamogeton nodosus) when the filled pond was treated, but the tributylphosphate killed the fish.

When a pond containing Potamogeton nodosus was drained and the bottom sprayed with 2,4-D in tributylphosphate at the rate of 10 pounds per acre, new shoots failed to appear. Chara was unaffected, however, and flourished in the pond after this treatment.

In a pond treated with 2,4-D in triethanolamine and water at a rate which produced a concentration of 10 p.p.m. in the pond water, Naias flexilis and Potamogeton foliosus and P. filiformis were quickly destroyed. Again, Chara, which was abundant in the pond, was unaffected.

Water Lily

Experiments on the water lily (Nuphar advena and an ornamental variety of the Nymphaea) are still in progress. Sprayed on the leaves at the surface of filled ponds, 2,4-D in tributylphosphate and in triethanolamine has proved ineffective. These sprays caused surface leaves to curl; and the petioles became spirally twisted or otherwise contorted (figure 7), but only a few were killed. Figure 8 shows a clump of untreated lilies.

Ammonium sulphamate at the level of 10 pounds per acre also proved ineffective in ponds at normal stages although it did kill a few leaves.

In the most recent experiment at Leetown, the leaves and petioles were sprayed with a 5-percent solution of 2,4-D in tributylphosphate and kerosene after water had been drained from the pond. The leaves and petioles were destroyed.

On April 8, 1947, an inspection of pond I-5 (at Leetown), in which the water-lily beds had been treated in this manner, found few new shoots appearing in the sprayed areas. Numerous new shoots were about 4 inches high in the control area. In tub experiments, leaves and petioles were killed back to the rootstalks by one treatment. These were transferred to indoor aquaria for observation during the winter. New sprouts with highly curled leaves and convoluted petioles developed from all rootstalks thus transferred.

A second spraying with a 5-percent tributylphosphate solution has apparently killed these plants.

PREPARATION OF SPRAY SOLUTIONS

A 5-percent solution of 2,4-D has been found very satisfactory for most plants, but higher concentrations may be necessary on the more resistant species.

Solutions may be prepared as indicated in table 1. The 2,4-D should first be dissolved in the cosolvent, then diluted with the carrier, and thoroughly mixed before use. The 2,4-D is soluble in water to the extent of about 3 percent if small quantities of ammonia (ammonium hydroxide) or washing soda (sodium carbonate) are used to aid solution. Selling at approximately $1 per pound, 2,4-D may be obtained from most chemical-supply houses. The ammonium or sodium salts generally are slightly higher. They may be dissolved directly in water to produce a 3-percent solution. Tributylphosphate may be obtained at a cost of about 50¢ per pound in bulk, or approximately half the cost of 2,4-D. The current price of triethanolamine in small lots is about 75¢ per quart or $3 per gallon.

The sprays may be applied with garden- or orchard-spray equipment, but such equipment must be thoroughly cleansed before it is used on desirable vegetation. If oil sprays are used, the equipment should be rinsed with kerosene; if aqueous sprays are used, a dilute solution of washing soda is an effective rinse.

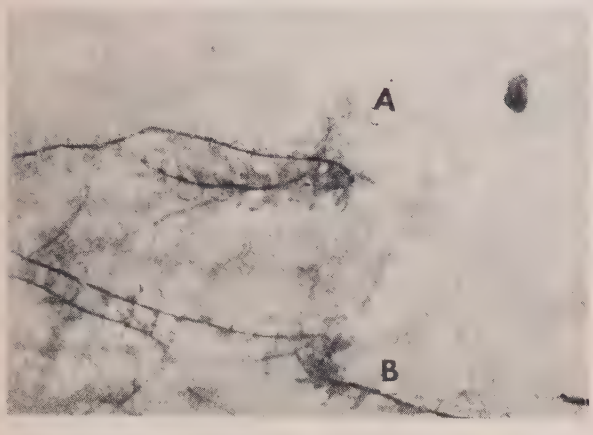

Figure 5.--(A) Terminal bud of Anacharis canadensis after being stimulated to very rapid, profuse growth in aquarium containing water treated with 2,4-D at 5-p.p.m. rate. (B) Leafless section of black, constricted stem.

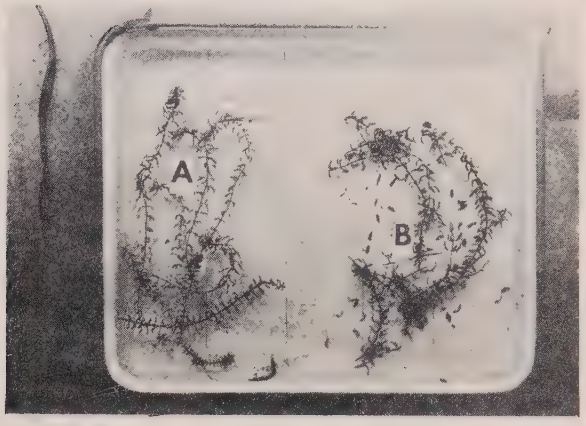

Figure 6.--(A) Untreated Anacharis stems showing normal condition, terminal buds and leaves intact. (B) Anacharis treated with 2,4-D. Note absence of terminal buds; many leaves have fallen from stems because of handling.

Figure 7.--Contorted petioles and leaves of water lilies (Nymphaea), after 2,4-D treatment. These later recovered.

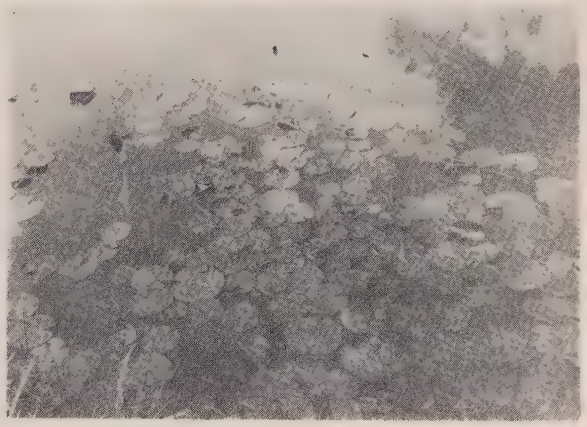

Figure 8.--Untreated patch of water lilies (Nymphaea).

TABLE 1.--Composition of spray solutions

Solution No.	2,4-D		Cosolvent		Carrier to make 5 gallons
	Percent	Weight (pounds)	Name	Volume (quarts)	
1	5	2	TBP	2	Kerosene
2	5	2	TEA	1	Water

TBP - tributylphosphate
TEA - triethanolamine

LITERATURE CITED

Bauman, A. C.
1947. 2,4-D and some emergent aquatics. Prog. Fish-Cult. 9 (2): 71-77.

Ennis, W. B., Jr.; Thompson, H. E.; and Smith, H. H.
1946. Tributyl phosphate as a solvent for preparing concentrated and oil-miscible solutions of 2,4-dichlorophenoxyacetic acid and similar substances. Science 103 (2677): 476.

War Department, Chemical Warfare Service, Special Projects Division, Camp Detrick, Maryland.
1946a. Contributions from Special Projects Division. Bot. Gazette 107: 475-634.
1946b. Plant growth regulators. Science 103 (2677): 469-470.

The Service offers neither recommendation nor endorsement, but for the convenience of readers some sources for these materials are listed:

2,4-D:
Dow Chemical Company
Midland, Michigan.

Amend Drug and Chemical Company
117 East 24th Street
New York, New York.

Sherwin-Williams
1800 Guild Hall Building
Cleveland, Ohio
and
Chicago, Illinois.

American Cyanamid Company
30 Rockefeller Plaza
New York 20, New York.

J. T. Baker Chemical Company
Phillipsburg, New Jersey.

Tributylphosphate:
Commercial Solvents Corporation
Terre Haute, Indiana.

Amend Drug and Chemical Company
117 East 24th Street
New York, New York.

Ohio Apex Company
Nitro, West Virginia.

Triethanolamine:
Carbide and Carbon Chemical Corp.
30 East 42d Street
New York, New York.

Amend Drug and Chemical Company
117 East 24th Street
New York, New York.

Dow Chemical Company
Midland, Michigan.

Dyes:
Calco Division of American Cyanamid
Bound Brook, New Jersey.

E. I. DuPont Company
Wilmington 98, Delaware.

Eimer and Amend Company
Third Avenue, 18th to 19th Street
New York, New York.

Fisher Scientific Company
Pittsburgh, Pennsylvania.

THIS QUESTION OF ANEMIA

WHAT IT IS AND WHAT TO DO ABOUT IT

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and

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What is Anemia?

THE BLOOD STREAM contains millions of small, round-to-oval red cells. These bodies, called red blood cells or red blood corpuscles (erythrocytes to the physiologist), give blood its characteristic color. The main purpose of these tiny cells is to carry oxygen to the various parts of the body so that life may exist. The number of red corpuscles in the blood stream determines the oxygen-carrying capacity of the blood. In human beings the male normally has about 5 million per cubic millimeter of blood and the female has about 4.5 million. Such a load of red cells permits the normal functions of the body. When this number is reduced, the oxygen-carrying capacity of the blood is lowered and the various tissues may suffer considerably. The reduction of the red cells is known as anemia. In severe anemia the number of corpuscles is drastically reduced and the body actually experiences a gradual suffocation that may eventually result in death.

In human beings there are three main causes for reduction in the number of red cells in the blood. First, there are the dietary deficiencies. This means that the food lacks some of the minerals (iron, copper, or cobalt) or some of the various vitamins necessary for normal blood. The corrective measure is, of course, the addition of the elements missing from the diet. A second cause is some sort of upset in the normal mechanism of the body: this may result in what is known as pernicious anemia. The discovery that liver and liver extracts would relieve pernicious anemia was one of the greatest dietary advancements of our time. Fortunately, only a few persons are affected with pernicious anemia. The third major cause of anemia is hemorrhage or excessive loss of blood. Such bleeding may be caused by accidents, stomach ulcers, or various other abnormal conditions, including heavy infestations of blood-sucking parasites.

Anemia is recognized by a number of symptoms. The most reliable means of diagnosis is the process of taking a known quantity of blood and actually counting the number of cells present. From this sample the number of cells can be estimated and the presence of anemia thus determined. An anemic person usually lacks the "redness" of skin that we associate with good health. Anemia is characterized by loss of appetite, lack of stamina, and inability to do a good day's work without tiring.

We have spoken of the factors that reduce the red-cell content of the blood, but there are conditions which raise the red-cell content. Excitement, fright,

exercise, heavy work, and emotional upset will cause a temporary increase in the number of red corpuscles in the blood. During periods such as these the body has a temporarily greater demand for oxygen, increases the red-cell content of the blood, and thus increases its oxygen-carrying capacity. Persons residing on mountaintops usually have a blood count higher than that of persons living at the seashore. The reason for this is that less oxygen is available in the air on the mountaintops and the body must increase the oxygen-carrying capacity of the blood. There are other causes of red-cell increases which are detrimental to the body. These are pathological in nature and require medical attention.

Anemia in Hatchery-reared Trout

Among hatchery-reared trout, anemia is a more common cause of mortality than is usually believed. It becomes a minor problem, however, if the proper precautions are taken. The best cure for anemia is prevention, and prevention under ordinary circumstances should be a relatively easy matter.

At hatcheries that have ponds ice-covered for long periods, it is particularly important that fish be free from anemia at the start of the winter. The food intake of the fish during the winter is low, and a slight anemia in the fall can be very serious by spring.

The normal blood count of a hatchery trout varies from 1.1 to 1.2 million cells per cubic millimeter of blood. For some unknown reason the blood count of hatchery trout is somewhat lower than that of wild trout. Perhaps our hatchery foods lack some essential that trout in the wild obtain.

In trout, as in the higher animals, anemia results in a gradual suffocation to the point where death may occur. Fish that are anemic have gills that vary from a pale pink to a whitish color. They lose their appetites, become "pin-headed," cease growing, and become quiet, lying about the ponds and troughs with as little movement as possible. In addition, anemic fish have livers that are quite yellow and show little or no reddish cast.

It is possible through the use of blood counts to diagnose anemia during the early stages, and thus curative measures may be taken before the fish lose their appetites. Fish that have lost their appetites are usually hard to bring back to normal: if fish are not feeding, it is impossible to cure dietary anemia.

Blood counts are not difficult to make although considerable practice is needed to become skillful. The technique of making blood counts upon trout has been described by Phillips (1940). Experiments have shown, however, that a low oxygen content in the water will increase the blood count of fish. A fish in such water makes an increased demand upon the carrying capacity of its blood, and it responds by increasing the number of red cells. In diagnosing the early stages of anemia, we should be sure that the oxygen is not raising the blood count and hence giving a false picture.

As in the higher animals, there are several causes of anemia in fish. In a pond of fish there are always a few that have pale or white gills. This may be true pernicious anemia, but so few are affected that it is of little importance. Anemia may result from severe infestations with blood-sucking parasites upon the gills and body of trout: this anemia is due to the loss of blood. The treatment, of course, is to remove the parasites by one of the standard methods recommended. Fatty degeneration of the liver may be accompanied by an anemic condition. However, most anemia in a hatchery is doubtless of dietary origin. So important is this that the problem will be dealt with in considerable detail.

Dr. McCay showed in 1927 that fish could not be reared on diets lacking in fresh meats, that the fish soon died in large numbers if this was attempted. Dr. McCay postulated that fresh meats provided some essential that was lacking in other ingredients of the diet, and he called the mysterious substance "Factor H." In 1940 it was shown that fish fed on meatless diets were severely anemic when losses were experienced and the inclusion of beef liver corrected this condition. It is now well known that many meat products contain the unknown element that is so essential to the well-being of trout. It has been

found that dry heat will destroy Factor H, but ordinary cooking does not completely eliminate the anti-anemic property of the meats. Apparently Factor H is subject to oxidation (reaction with the oxygen of the air), and this is one means of its destruction.

Since Dr. McCay's report many experiments have been made in efforts to determine just what Factor H is. Simmons and Norris of the University of Washington found that a new vitamin, xanthopterin, was effective in curing some cases of anemia. The Cortland workers reported that a mixture of pyridoxine, pantothenic acid, and riboflavin, all members of the vitamin-B complex, would cure anemia. In later experiments they could not repeat this work but they did show that anemic fish had extremely low storage of these vitamins in their livers, a circumstance supporting in part the view that these vitamins do play some role in trout anemia. These same workers thought at one time that commercial liver extracts, used in the treatment of pernicious anemia in human beings, would prevent anemia in trout. Such conclusions did not stand the test of time; obviously, some unknown factors were entering the experiments. Recently the Cortland workers have found that folic acid, added to pyridoxine, pantothenic acid, and riboflavin, does have some beneficial effect upon anemic fish but does not effect a full cure. The work to date indicates that Factor H is not really a single factor but is probably many factors, all necessary for the prevention of trout anemia. It would probably be better to refer to Factor H as the anti-anemic factors.

We have already said that one of the causes of dietary anemia in trout is the lack of fresh meat in the diet. There are several other causes that many hatcheries do not always take into consideration. Diets of poor consistency will often cause anemia. Such diets fall apart when placed in the water, and much of the food is lost to the fish. This lost food includes many of the valuable anti-anemic factors of the diet. Diets that are well bound (as by the use of salt) will prevent this loss and preclude anemia.

It is the practice of some hatcheries to grind and mix their food for several days' or even a week's feeding. This results in a certain amount of spoilage of the food and destruction of many of the valuable anemia-preventing properties of the diets. Oxygen can combine with these elements in the food, resulting in their destruction. Such a process will occur particularly if the food is kept only at ordinary refrigeration temperatures. Food thawed and ground even for relatively short periods (24 to 48 hours) can lose much of its nutritive value. This is probably one of the main causes of nutritional anemia in hatchery trout. When foods are mixed for long periods, one food may react with another to destroy the essentials. This has been shown by the result when salmon flesh is mixed with fresh meats: in some manner the salmon flesh destroys the anti-anemic factors of meat standing for periods as short as 24 hours, and fish fed these diets become anemic and die in large numbers. It has also been shown that many other varieties of frozen fish destroy the vitamin B_1 of diets, and the result is a loss of trout through a vitamin B_1 deficiency when such food is fed. It is obvious that the use of such foods after periods of standing (in excess of 24 hours) can be very dangerous.

Underfeeding, especially where dry feeds replace a portion of the meat in the diet, can result in anemia. This is because the fish are not getting sufficient meat to prevent the development of anemia. The prevention or cure here is to increase the food allowance, not to eliminate the dry feed from the diet.

In many regions the practice is to hold the meat supply for long periods at ordinary refrigeration temperatures. If meat is to be held for long periods it should be frozen and not thawed. This will assure maximum preservation of the valuable dietary essentials.

There is a difference among meats as to potency in preventing anemia. Muscle meats (horse and beef) are generally considered much poorer sources of the anti-anemic factors than the organs commonly used (livers and spleens). When muscle meats are fed at relatively low levels as the sole source of fresh meat, an anemic condition may develop.

The use of fluke-infested pork and sheep livers that have been denatured by dyeing (as required by law) can be dangerous. Livers such as these will not prevent anemia although the fresh livers of sheep and hogs will. Dyed beef liver is a satisfactory food. It is thought that the dye is the destructive factor in these livers. In sheep and hog livers the dye penetrates almost entirely through the liver, whereas in beef liver the degree of penetration is only about 1 inch. If just the penetrated area of the beef liver is used, an anemia will result. It has been concluded that the action of the dye destroys the anti-anemic properties of these livers.

LITERATURE CITED

Phillips, A. M.
1940. Meatless diets and anemia. Prog. Fish-Cult. 48: 11-13.

COMPARATIVE SENSITIVITY TO DDT IN AQUARIA

Under the direction of Mr. E. W. Surber of the U. S. Fish-Cultural Station at Kearneysville, West Virginia, experiments have recently been conducted in 5-gallon aquaria to compare the sensitivity of several species of fish to DDT. Experiments in outdoor ponds have already indicated that rainbow trout are less sensitive to DDT than smallmouth black bass, largemouth black bass, golden shiners, bluegill sunfish, and black crappies when exposed to 0.18 parts per million of DDT in ponds treated at a rate of 1 pound per acre.

In aquarium experiments involving 0.25 and 0.5 pound of DDT per acre (0.12 and 0.28 p.p.m., respectively), all bluegill sunfish died, but blacknose dace (Rhinichthys atronasus) and bluntnose minnows (Hyborhynchus notatus) survived both rates of DDT whether in the oil-spray or in the wettable form. Darters (Catonotus flabellaris) and sculpins (Cottus cognatus) were more sensitive than dace and bluntnose minnows. Of the darters, 22 percent died at 0.25 pound of DDT per acre, but 89 percent died at the 0.5 rate; the mortality of the sculpins was high at both rates.

In a recent experiment nine trout--three brook, three rainbow, and three brown--about 1.2 inches long were placed in each of 14 aquaria, 7 of which contained 2 liters of mud. One aquarium containing mud and another without mud served as controls. The remaining 12 aquaria were treated with wettable DDT at the rate of 0.25 pound per acre (0.12 p.p.m.). In the controls, all brook and rainbow trout lived, but one brown trout died. In the treated aquaria without mud, mortality among all species ranged between 84 and 100 percent. Rainbow trout seemed more sensitive. In aquaria containing mud, all brook trout and most of the brown trout lived. Mortality among rainbow trout was 39 percent, again indicating that rainbow trout are more sensitive to DDT (in aquaria) than either brook or brown trout, and that organic material adsorbs DDT, reducing the hazard to fish.

These aquaria were operated without aeration and without an inflow of water. The temperature ranged from 51° to 60.5°, the average being 54.2° F.

FARM PONDS

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Location, construction, stocking, and management are determining factors in the success of farm ponds intended primarily for fishing. Clear water in the growing season, a source of water permitting some degree of control of levels and economical fertilization, as well as control of vegetation, are prerequisites. Good fishing depends upon the establishment and maintenance of a balance between the predator fishes and supporting populations. To date, efforts at education along these lines have been confined largely to various forms of literature. Practical, technical assistance in the field is the best form of instruction.

ORDINARILY farm ponds are constructed for swimming, boating, fishing, duck shooting, stock-watering, irrigation, and related activities. Fishing is the primary purpose in our southeastern States.

The basic idea in the success of the farm pond is to get the pond located, constructed, stocked, and managed in such a way as to develop and maintain a balance between the predator fishes and their supporting population. Unless such a balance is established and maintained, the pond will provide very poor fishing.

The minimum requirements are that the pond be located and constructed to provide for clear water during the growing season, and that the water source be so limited as to permit reasonable maintenance of water levels and economical fertilization. The bottom should slope steeply at the edges to discourage rooted aquatics.

A pond with these prerequisites can be stocked with about 100 largemouth black bass and 800 to 1,500 bluegill sunfish per acre in fertile waters with an excellent chance that a balance will be established. The Fish and Wildlife Service stocks ponds at the rate of 100 bass and 1,000 bluegills per acre for fertilized ponds. This rate varies according to the amount of

Typical farm fish pond capable of producing a considerable quantity of food fish.

error in the applicant's or his sponsor's estimate of the pond area. An error of 10 percent provides for a stocking of 110 bass and 1,100 bluegills, one of 20 percent for 120 bass and 1,200 bluegills, and one of 50 percent for 150 bass and 1,500 bluegills. Rarely are acreages underestimated in applications for fish.

The examinations made by biologists of Federal and State agencies indicate that on ponds from Texas to Georgia the stocking rate of 100 bass and 1,000 bluegills per acre is giving results. Reports from the northern States suggest that that rate is unsatisfactory, that it often results in an overpopulation of bluegills. This overpopulation occurs, it is believed, because the bass delay reproduction until after they have been in the pond two full seasons instead of one as in the South.

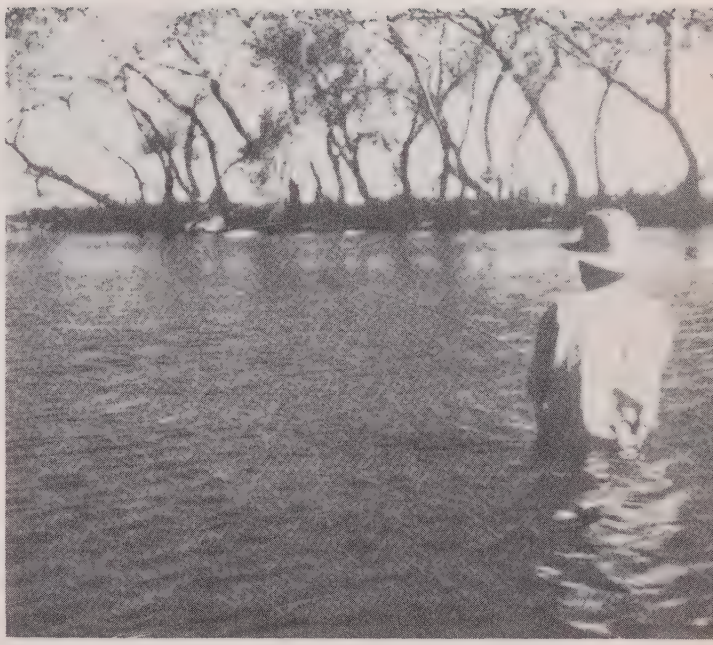
Where crappie, catfish, and other species have been used with bass and bluegills, results often have been unsatisfactory. Either the crappie, catfish, and other species have disappeared for the most part after a few years, or a balance between the predator and supporting populations has failed to develop or maintain itself. Shellcrackers (red-eared sunfish) in combination with bluegills have given satisfactory results. It appears important to use bluegills in combination with shellcrackers in order to provide young sunfish throughout the growing season for the bass. If bluegills are not used, there is the possibility that the bass may go through the winter in poor condition, resulting in poor (if any) bass reproduction the following spring and an overpopulation of sunfish later. The research programs have not provided any combinations (except those that include bass and bluegills) which can be used with any degree of certainty.

An important factor in management of farm ponds is control of the vegetation. Whenever large areas of the pond bottom are permitted to become covered with growths of aquatic plants, the balance is lost, resulting in an overpopulation of bluegills and poor fishing. Literature on the use of fertilizers in farm ponds has stressed increased production. As most farm ponds appear to be utilized below their capacity, it would appear that the poundage of fish produced is not important in most ponds. The important thing is whether there is good sport fishing. Fertilizer, then, should be used for weed control: production will be of secondary importance, a satisfactory by-product.

Some writers have taken great care to recommend certain types of fertilizers with definite amounts to be applied at specified intervals throughout the growing season. As the primary purpose is to

establish sufficient turbidity with unicellular algae to control rooted vegetation, it would appear best to use comparatively heavy applications of fertilizer early in the growing season to establish a "water bloom" and then only enough to maintain it. The variable results from pond to pond and year to year in developing and maintaining a turbid water bloom suggest that we know too little about fertilizer needs to make any precise recommendations that will have very broad application. Apparently an inorganic fertilizer comparable to an 8-8-4 in nearly neutral waters (the nitrogen increased and the phosphoric acid slightly reduced in hard waters, and the reverse in acid waters) approaches the need for development and maintenance of a water bloom. Potash is desirable, but many waters apparently carry sufficient quantities of this ingredient--or perhaps its importance has been overemphasized. As organic fertilizers usually do not produce large quantities of unicellular algae, their use in farm ponds should not be recommended as a general policy except in conjunction with inorganic fertilizer to establish a bloom in the early part of the season in very hard water or to clear muddy ponds in which the coloring substance would otherwise be held in suspension for long periods.

Much has been said about lack of utilization of the fish produced in farm ponds. It is my opinion that the public should be educated along the line that



Trees inadvisable on dam. Obstructions to fishing can be avoided by proper planning of construction.

fertilized farm ponds cannot be overfished (balance destroyed) so long as the fish are removed in the ratio of about 1 pound of bass to every 3 or 4 pounds or more of bluegills. There is evidence that only about 40 to 50 percent of the weight of the available fish can be readily removed by hook-and-line fishing, but it is not conceivable that small ponds can long maintain their balance with unduly heavy fishing for bass.

Several Federal and State agencies have published some very fine literature regarding the construction, stocking, and management of farm ponds. My experience in contacting sportsmen and pond owners is that this literature has been of little direct value to them. It has provided background information for technical and administrative men, who have passed this information on to pond owners successfully only when furnishing advice on the ground. Even the most intelligent pond owners rarely understand or are able to apply the recommendations in the literature without technical assistance in the field. The pond owner can write to any one of several conservation agencies for help in the construction and management of a pond. He is almost certain to receive a

pamphlet that contains all the answers, few of which he understands. He is very unlikely to receive help on the ground unless he happens to belong to a Soil Conservation District, has a sympathetic County Agricultural Agent, or lives in one of the States where the Agricultural Extension Service or a State conservation commission has an active pond program. The pond owner is very unlikely to receive any help in the field for the simple reason that the number of trained technicians on the payrolls is insufficient to go around.

Unless qualified men are made available through some agency, we shall have fumbled the ball on one of the best scoring opportunities the conservation field has offered. In the past, efforts at education in this field have been confined largely to literature; yet, considering the type of individual to be educated, this is the least efficient of the several methods available. There is no substitute for advice given on the ground, as each prospective pond has problems of its own and follow-up inspections are necessary if all the desirable attributes and corrections are to be effected. A series of appropriate lantern slides with an accompanying talk is second best and has the advantage of reaching more people. A good motion picture would be much more valuable, probably, than dollar for dollar invested in educational articles. Inspections made in the field, preceded by lantern-slide talks, would be excellent. A combination of all these methods would be ideal for a well-rounded educational program.

The educational field is only one of our failures. Perhaps the research boys eventually will provide us with help on some of the others. Pond owners and sportsmen have been asking me these questions:

1. With what should I stock my pond, one-half of which is full of weeds? I don't have money to fertilize.
2. I have a pond with an abundance of excellent duck foods, which have been developed over a period of years. What should I do to get good fishing along with the duck-shooting?
3. How do I raise catfish for the market?
4. What do I do to get started in the mullet business?
5. I want to raise carp. Where do I get them? Can I feed them corn? Is there any other fish which would produce more meat?
6. I have a 1/10-acre pond. Can I raise bait minnows? What species do I use? Where do I get brood stock? How do I fertilize and manage the pond? How much a dozen can I get for them? How many can I raise?

If these questions pertained to agricultural crops, would not our fishery technicians provide better answers than they supply with our present knowledge of aquatic crops?

Mud-hole not suitable for fish.

Alexandrian rat.

Norway rat.

RAT CONTROL ON FISH-CULTURAL STATIONS

Thomas B. Murray
Fish and Wildlife Service
Chicago, Illinois

UNKNOWN in the United States prior to the arrival of Europeans, the rat has everywhere followed settlement until now its numbers closely approximate those of the human population throughout the country. It is estimated that half the total are on farms, about 26 percent in nonfarm country residences and in towns of less than 10,000 population, and about 24 percent in cities of 10,000 or more. Under these circumstances it is no disgrace to have rats appear on a fish-cultural station, but it is a disgrace to keep them.

SPECIES ON FISH-CULTURAL STATIONS

The Norway or brown rat (Rattus norvegicus) is common throughout the United States. The average adult weighs about three-quarters of a pound and has an over-all length of 16 to 18 inches (inclusive of the tail, which may be 7 to 7½ inches long). This common house rat has a robust body and short ears. Usually a grayish brown on back and sides, the coloration may fade to a dirty silver gray or pale yellowish white on the belly. Individuals may vary in color from an almost pure gray to reddish brown or nearly black, and partial albinos are not rare. (The white rat commonly bred for laboratory use is a type of Norway rat.)

The long-tailed roof or tree rat (R. r. alexandrinus) is found mainly in the Gulf and Atlantic seaboard areas. The average adult weighs less than three-quarters of a pound and has an over-all length of 15 to 17 inches (inclusive of the tail, which is longer than the body). The ears of the Alexandrian rat are longer than those of the common house rat; and the long, narrow feet of the former are better suited for climbing. The Alexandrian is gray to bluish gray with slight tinges of brown and a pale-colored belly.

Either or both of these rats may find suitable habitat and take up residence

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See also:

Hamilton, W. J.
1936. Rat control in the hatchery.
Prog. Fish-Cult. 16: 6-7.

on the average fish-cultural station.

HABITAT CONTROL

Food and cover are the critical factors to be considered in controlling an actual or potential rat infestation on any station. All buildings and space used for storing and mixing fish foods, as well as grain- and feed-storage areas used for domestic livestock, must be rat-proofed. All new construction should be of rat-proof design and construction.

Rat-proof containers should be provided for garbage and other refuse. All trash that can be burned should be destroyed in an incinerator. All reserve supplies of lumber, posts, and firewood should be stacked in compact piles, on platforms or cribs that are raised more than 1 foot from the ground.

Grass, weeds, and shrubs require periodic cutting, burning, or control by grazing to remove food and cover for rats. To close rat holes and discourage the digging of new burrows, any embankments, levees, and other earthen water-control structures must be compacted.

CONTROL OPERATIONS

The job of cleaning up or removing an infestation of rats requires careful and painstaking use of baits, traps, and fumigants. Control measures should be adapted to local conditions.

Poisoning

The use of poison is the most efficient known, and the most generally recommended, means of destroying rats. The chief objection to the use of lethal baits is the danger to human beings and domestic animals. This objection can be met by exercising proper care in exposing and cleaning up lethal baits.

Red Squill is made from a perennial onionlike bulb that grows wild along the coast of the Mediterranean. The bulbs are picked in the dormant stage, sliced, dried, and ground to a fairly fine powder. As a rat poison, red squill has the distinct advantage of being relatively harmless to human beings and domestic animals. This is due in part to its acrid taste, which is highly objectionable to most animals, and to the fact that it usually acts as an emetic when taken in dangerous quantities. Rats take red squill fairly readily, however, and because these animals do not vomit, this poison approaches the unique position of being specific for them.

The chief objection to squill is that its toxicity may vary considerably because of lack of toxicity in the parent strain of squill, which may be influenced by soil, climate, or conditions under which the bulb is harvested and processed. This objection has been largely overcome by "fortification" of low-toxicity squill to provide a powder or liquid squill extract of uniform toxicity. The Wildlife Research Laboratory of the Fish and Wildlife Service, Denver, Colorado, has worked out methods of fortifying the red squill and of bioassaying the fortified product to determine its degree of toxicity. High-toxicity squill powder and extract should be available from the manufacturers during 1947. Red squill should find increasing favor and use as a raticide as the quality of the fortified product is improved.

Zinc Phosphide is an inorganic compound prepared as a finely ground black powder for use in preparing lethal rat baits. It has a distinctive odor resembling garlic. Neither the color, odor, nor taste appears to deter rats from eating baits prepared with zinc phosphide. This material is lethal to domestic animals and to human beings.

Antu (Alpha-Naphthylthiourea) is a light-grayish powder, almost insoluble in water and toxic to Norway rats. It was developed during World War II and has been widely advertised as a raticide during recent months. Young Norway rats have a relatively high tolerance for antu, and any rats that have survived a sublethal dose will refuse for several weeks to eat baits containing it. Antu has been widely publicized as "trail" or "tracking" bait. To be effective when used in this manner, the trails should be covered with at least a 10-foot strip or band of antu powder. It is of very little value for use as a water bait. This poison is dangerous to dogs and other domestic animals. Monkeys are highly susceptible, and it is presumed

that man would be likewise affected.

Thallium Sulphate is a dense white powder made from metallic thallium, which is similar to lead in physical properties. This is a cumulative and powerful poison, slow-acting and certain in its results. It has no objectionable taste or odor; it is the one poison that can be used as a clean-up or follow-up bait where antu, red squill, or other lethal baits have not given desired results. Lacking distinctive taste, smell, or color, and being readily absorbed through the skin, thallium sulphate is most dangerous to human beings and domestic animals and should be used only with the utmost caution. This poison is barely soluble in water; it is not a first-class liquid or drinking bait for rats.

1080 (Sodium Fluoroacetate) is a fluffy white powder, highly hygroscopic, and readily soluble in water. To the human taste it has a mild salty-sour flavor that is neither distinctive nor objectionable. In solution in water, 1080 appears to have neither taste nor warning factor for rats. When incorporated in feeding baits, the poison gives evidence of a taste or warning factor to rats, and acceptance is sometimes spotty.

The relatively high toxicity of 1080 to man and to domestic animals precludes its use except with utmost caution and by experienced personnel.

Suggested Bait Formulas.

All materials used in rat baits must be kitchen-fresh and of best quality. Mixing boards or containers, paddles, and spoons must be scrupulously clean. Mixed baits should be put in new containers, stored in clean, cool, odor-free room or compartment, and used as soon as possible. Poisons may be mixed with various baits as shown in table 1.

Formula No. 1

	(pounds)
Ground bread crumbs	8
Ground fresh pork fat	2

Formula No. 2

Breakfast rolled oats	6
Fresh-ground hamburger beef or lean horse meat	4

Formula No. 3

Breakfast rolled oats	5
Fresh-ground, fresh-caught edible fish	5

Grind together the ingredients of the particular formula, stir in the selected powdered poison in the proper amount, and mix for 10 minutes to get a thorough mix or blend of the poison with the bait material.

1080--Poison Water Formula

Dissolve ½ ounce of 1080 in 1 gallon of cold water. Keep this solution in a plainly labeled glass jug. The solution can be exposed in 1-ounce paper souffle cups or in baby-chick watering devices placed along rat runways or adjacent to rat feeding points. It must be used with great care and by experienced personnel only.

If any type of permanent poison or control station is necessary to control a constantly recurring rat infestation, then it may be necessary to construct a fool-proof cover for a 1080-water station or stations, so placed that all invading rats will go through or come in contact with these stations.

TABLE 1.--Quantity of poison to use with bait

Kind of poison	Amount (ounces)	Bait material (pounds)
Red squill	16	9
Zinc phosphide	1	3
Thallium sulphate	1	4
1080 (Sodium fluoroacetate)	1	25
Antu (Alpha-naphthylthiourea)	1	6
1080 (Sodium fluoroacetate)	½	1 gallon of water

Prebaits and Poisoned Baits.

A survey should be made to determine location and density of rat colonies on and adjacent to the hatchery site. The

work plan should include a thorough coverage of the area to prevent any chance of missing some rats.

Bait materials should be prepared with any suitable formula minus the poison. This prebait is to be distributed, a teaspoonful to a place, in clean, well-protected or sheltered spots where rats will travel or feed. Paper souffle cups (shallow, 1-ounce) make excellent feeder dishes, keep the bait dry and clean, and facilitate pick-up of unused material. Unpoisoned bait should be exposed for 3 to 5 days, the feeder dishes refilled at least every other day. At the end of the prebaiting period all dishes should be carefully picked up and burned.

Immediately after the pick-up of prebait material (the next day), the poisoned bait should be placed where prebait had been exposed. Every possible rat harbor and feeding spot should be covered. It is important that the same type of bait material that was used in the prebaiting period be used in the poisoned bait.

All bait spots should be visited on the second day. Bait cups should be refilled where poisoned baits were taken. Dead and sick rats should be picked up and buried or incinerated.

On the third or fourth day all poisoned baits and feeder dishes should be cleaned up and burned. Any unused bait material (poisoned or not) that will not be used immediately on other premises should be burned.

Fresh bait should be prepared for a repeat treatment at the end of 3 or 6 months if the infestation has not been cleaned up. Unless thallium sulphate was used originally, the same type of poison should not be used in repeat treatments. A change to a different type of bait material may increase bait acceptance.

Weather is the determining factor. Bait should be used during clear, calm spells. Spring and fall are generally the best times for good bait acceptance.

Trapping

Immediately after the "blanket" coverage of the premises with poisoned material and the subsequent clean-up of baits and dead rats, the entire area should be covered with traps. A number of traps should be carefully placed and baited to get the rats that may have been missed with poison. These traps should be tended daily and kept in good working order for about a week. Thereafter all traps should be picked up, cleaned, and stored for future use.

If a "straggler" rat appears on the station, a few well-placed traps should suffice to pick it up.

Systematic and periodic poisoning and trapping will keep the station free of rats and will preclude the possibility of building up a "poison-wise," "trap-wise," or "control-wise" rat population.

FRUSTRATION.

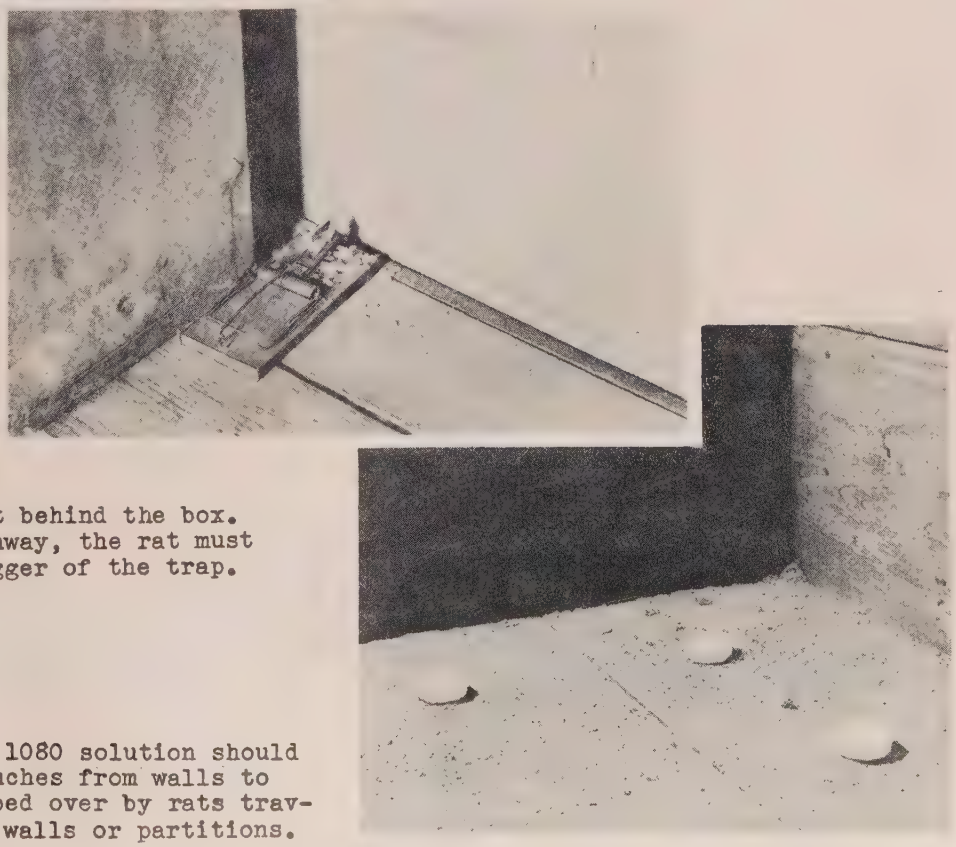
Fumigation

Calcium-cyanide dust may be used to destroy rats in their harbors or burrows along ditch banks and levees. This dust may be applied with a portable dust pump that has a flexible hose attached. Caution must be taken in the handling of this material.

ASSISTANCE

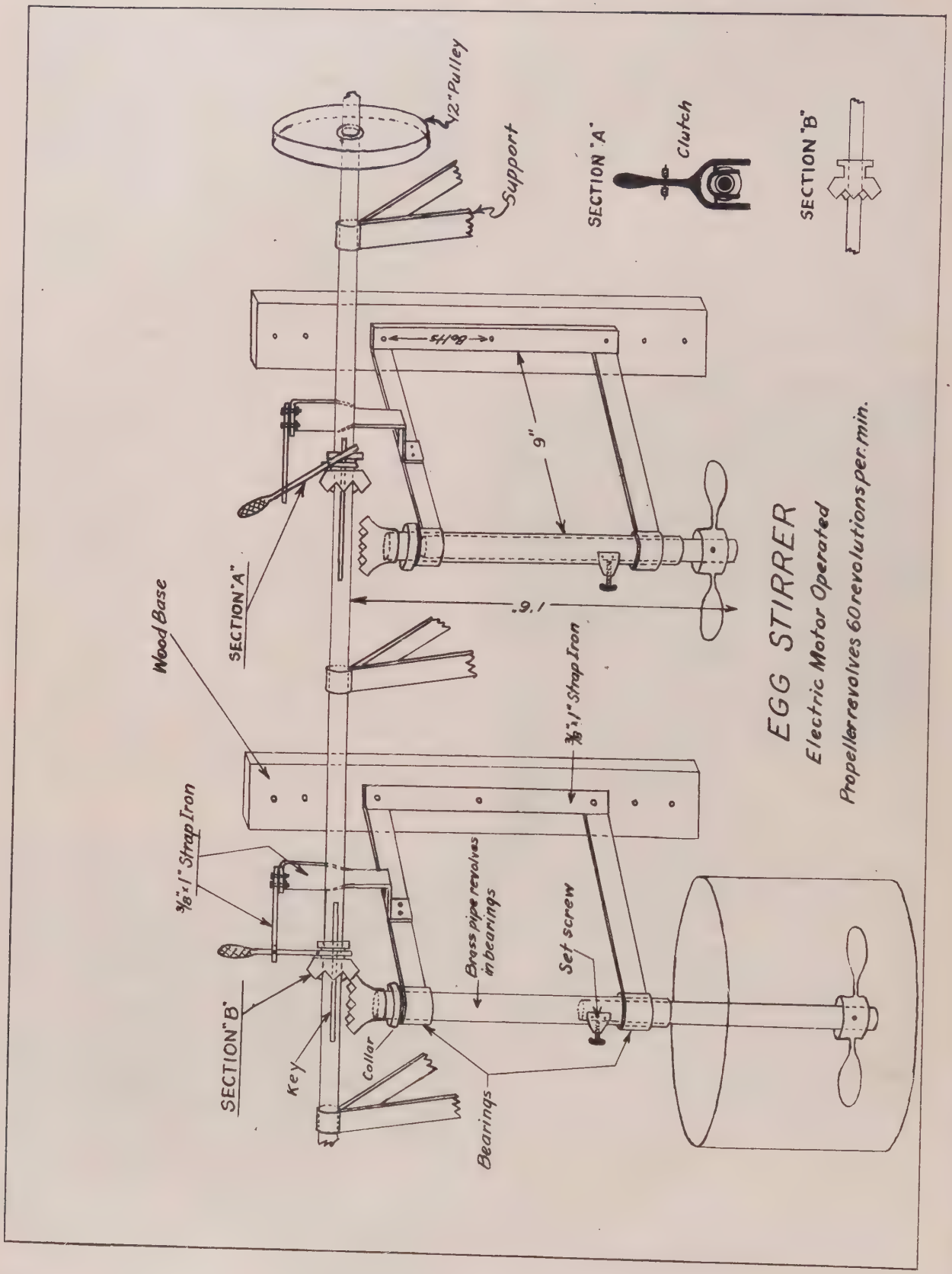
The Predator and Rodent Control Division of the Fish and Wildlife Service is prepared to furnish supervision and control materials for use on fish-cultural stations and premises that may have a rat-infestation and control problem. Requests for assistance may be made through any regional office of that Service--at 306 Weatherly Building, Portland 14, Oregon; 220 West Copper Avenue, Albuquerque, New Mexico; 828 Plymouth Building, Minneapolis 3, Minnesota; 310 Glenn Building, Atlanta 3, Georgia; 1105 Blake Building, 59 Temple Square, Boston 11, Massachusetts--or directly to the central office at the Merchandise Mart, Chicago 54, Illinois.

Souffle cups of 1080 solution should be at least 12 inches from foodstuffs or stored material to avoid contamination with 1080 if the cups are upset by rats.



The runway is just behind the box. When using the runway, the rat must pass over the trigger of the trap.

Souffle cups of 1080 solution should be at least 6 inches from walls to avoid being tipped over by rats traveling along the walls or partitions.


EGG STIRRER
Electric Motor Operated
Propeller revolves 60 revolutions per min.
Wood Base
SECTION "A"
SECTION "B"
3/8" x 1" Strap Iron
Brass pipe revolves in bearings
Set screw
Key
Collar
Bearings
Support
1/2" Pulley
Clutch
9"
9"

IMPLEMENTS IN FLOUNDER OPERATIONS

Thomas H. Dorr[1]
Fish and Wildlife Service
Boothbay Harbor, Maine

When spawning and hatching operations with flounders were undertaken at the Boothbay Harbor station early in the spring of 1909, we used five nets. The number of nets used has increased gradually from year to year until at the present time we are using between 90 and 100 fyke nets. These nets capture all the brood fish that we can handle successfully at the station; the fish so taken provide all the eggs we can care for with the hatching equipment available. We usually run two groups through each trough during the season.

The brood fish are captured with fyke nets attached to each end of a 100-foot leader. The fyke nets are usually about 3 feet in diameter. The leader is the same depth as the fyke nets, is made of No. 12 twine, and has a 4-inch stretched mesh. The fyke nets have a smaller mesh, especially in the pocket ends. Each fyke net has two small leaders (about 3 feet long) fastened to the first throat or opening of the net and stretched at an angle of about 45° from the 100-foot leader between the two fykes. These small wings guide the fish from the long leader into the fykes.

The nets are set in shoal water in sheltered coves at a depth of 3 to 6 feet. The nets are set the latter part of February and left during the spawning season, which ends late in April. All nets are hauled every day, and from the nets are taken the ripe female flounders and enough males to fertilize the eggs. These fish are taken to the hatchery and kept in holding tanks until the females are ripe enough to be stripped.

Many of the female fish that are captured during the day become ripe during the night and deposit their eggs in the holding tanks. In order that these may become fertile, some males are placed in the holding tanks with the females. The males and females go through the natural process of spawning and fertilizing the eggs deposited in the holding tank. To salvage these eggs, a receiving net is placed under the overflow pipe of the holding tank. Many such eggs are gathered from the bottom of the holding tank. By the time they are gathered, the natural-laid eggs have lost most of their adhesive quality. Any eggs that are still adhesive can be separated by rubbing through a fine mesh screen. This process of taking the eggs from natural spawning in holding tanks is still practiced at some of our stations where the number of brood fish taken is rather small.

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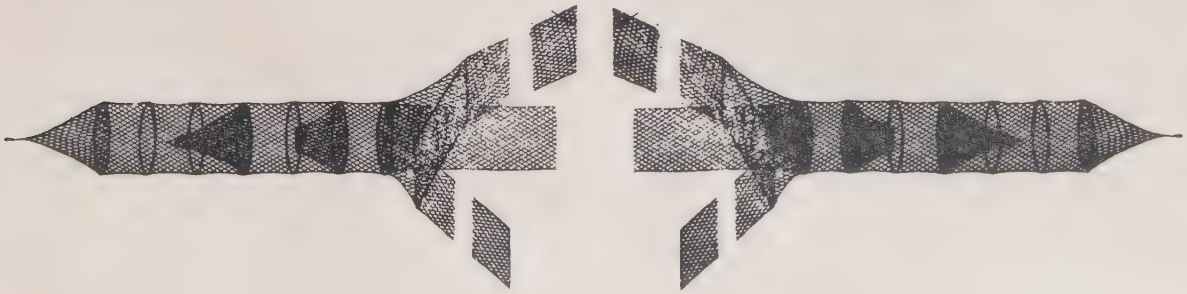
[1]Mr. Dorr retired from the Service on July 31, 1946.



At Boothbay Harbor we go over the fish in the holding tanks each day. We strip the females that are ready to release their eggs, and we fertilize them with milt stripped from the males, just as trout eggs are treated. We find that this allows us to handle a great many more adult fish, saves holding-tank space, and cuts down labor. All spent fish are taken back to the sea when a trip is made to haul the nets for more ripe fish.

Egg Stirrer

When taking the eggs artificially, we ran into one difficulty. The flounder eggs became very adhesive as soon as they were fertilized; all the eggs in a pan became a solid mass in a few minutes after fertilization. The old method of handling flounder eggs consisted of taking them in a cloth bag (2 to 3 quarts to each bag); after they were well hardened, an operator separated the eggs by rubbing them through his fingers. This method not only made it necessary for the operator to keep his hands in water 34° to 38° F. for 2 or 3 hours at a time, but caused many eggs to be ruptured. By this method it was impossible to separate all the eggs. Those that remained in clumps soon died for want of separation.

During the season of 1929, soon after I assumed charge of this station, we conducted a series of experiments to remedy the above method. In these experiments starch, muck, and other ingredients were stirred through the eggs every few minutes. Though there was a great improvement, the results were not considered satisfactory. Finally, eggs were placed in a jar and stirred with a paddle, water added, and the stirring continued for 1½ hours. At the end of that period it was found that all the eggs were separated and no signs of clumping remained. The eggs were then transferred to the hatching boxes and watched for some time, but no ruptured or clumped eggs were seen.

The results of this experiment indicated that the eggs artificially taken would lose their adhesive qualities if stirred sufficiently over a period of time. This involved a considerable amount of additional labor. My attention was then directed to finding some mechanical means of stirring the eggs, and the present fish-egg stirrer was devised.

The stirrer consists of a combination of pulleys, shafts, gears, levers, propellers, and glass cylinders 8 inches in diameter: the use made of these can be better understood from the drawing. The unit is operated by a 1/4-horsepower electric motor geared down so that the propellers make 60 revolutions per minute. While it is possible to have as many propellers as desired, our work requires only six and the apparatus is arranged so that one or all can be operated at will. Also, any one of the units can be cut out or started without interfering with the remaining propellers.

The newly fertilized eggs are placed in the glass cylinder to a depth of about 2 inches. The cylinder is then placed under the stirrer, and the propellers are started and water is added to the mass and kept in motion for about half an hour. At the end of that time the eggs are all separated and can be washed, measured, and transferred to the hatching boxes. At a temperature of 38° F., the eggs will hatch in 18 days. During the period of incubation the eggs are stirred every 2 hours; this, with the tidal boxes in operation, gives perfect circulation. As soon as hatched, the fry are removed and planted on or near the grounds from which the brood fish were taken.

Flounder Hatching Boxes

The flounder hatching boxes are, with a few changes, the same as the McDonald Tidal Automatic Hatching Boxes. Though the dimensions vary somewhat, those used at this station are 30 by 11-3/4 by 8 inches and fit in a trough large enough for ample space on all sides, with about 4 inches on each end for intake and overflow. A partition on the overflow end and cleats on the intake end make it possible to wedge the box in the trough.

Water is taken from the main supply pipe lines through a 1/4-inch rubber pet cock and conducted to the hatching trough through 1/2-inch rubber hose. At the outlet end a 1/2-inch brass pipe extends from 2 inches below the bottom of the

trough up through the bottom and to within 2 inches of the top. The siphon cap, which consists of a brass pipe 6 inches in length and 1-1/4 inches in diameter with an airtight top, is placed over the drain pipe, allowing 3 inches from the top of the siphon to the top of the drain. When the water has reached sufficient height in the trough, action of the siphon cap causes the water to drain down to the lower end of the cap, whereupon the siphonage is broken and the tank starts to refill. The hatching box is watertight on four sides, and the bottom is covered with fine mesh screen.

ALUMINUM HATCHING TROUGHS

A. C. Balch
Fish and Wildlife Service
Neosho, Missouri

During the war years, the old wooden hatching troughs in use at the U. S. Fish-Cultural Station, Neosho, Missouri, were patched and repaired repeatedly. At the close of the war, first-class cypress of the required dimensions was not available for the construction of new troughs and galvanized sheet metal (second choice) could not be obtained in this vicinity. While I was visiting a firm in regard to this work, I noticed a large supply of aluminum--aluminum sheet, angle aluminum, aluminum extrusion and channel stock. Members of the firm told me that this material had been purchased from surplus airplane-manufacture stocks, and they assured me that our troughs could be made from it.

The specifications submitted for our troughs called for 12-gauge aluminum. The sides and bottom were made of a single sheet, one aluminum seam welded across the center of the trough. The ends were welded into place. One-inch aluminum angle stock was riveted to the overlap around the top of each trough. Overflow spouts, 10 inches wide and extending 4 inches, were riveted and welded to the lower ends of the upper tier of troughs. (These wide spouts have proved very satisfactory, giving the water ample aeration for use in the lower tier of troughs.) The tail-screen channel slots, 3/4 inch wide and extending 1/2 inch within the trough, were made of molded aluminum channel. A lead gasket was placed between the drain (1-1/2 inches) and a floor flange which was riveted to the bottom of each trough. The drains were pipe-fitted, and standpipes were screwed into the flange to raise the water to the required depth in the troughs.

The aluminum troughs have proved very satisfactory throughout the current season. Exceptionally strong, the troughs do not sag or bulge; they should last a lifetime. For the first time in many years, the hatchery floor has been dry during hatching and rearing season. The troughs weigh 59 pounds each.

The cost per trough was $35.50, which was less than wooden troughs would have

been if the lumber had been available. Aluminum troughs could be constructed at a lower cost if some firm, using standard inside dimensions, would set up a jig to press out the troughs in large numbers.

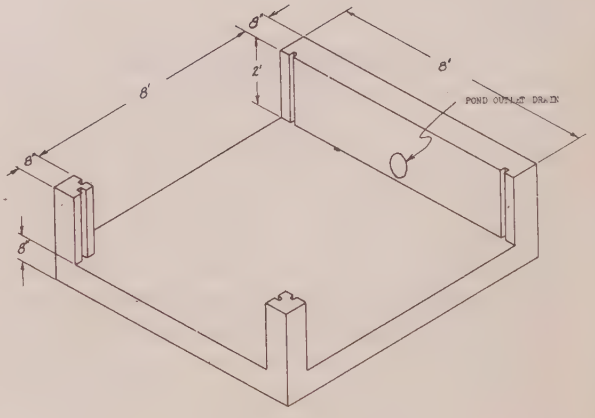
CATCH BASINS FOR UNFINISHED PONDS

Wilburn J. Whipple and Bernard L. Pelz
Fish and Wildlife Service
Westover, Virginia

At the Harrison Lake station in Virginia, two unfinished 5-acre ponds have extremely rough bottoms. A creek channel runs through each. There has been no grading. Depressions are drained by channels or ditches through the ridges and high spots.

Regular catch basins have been constructed in each pond but have proved inadequate for handling the fish when the ponds are drained. When the ponds are drained to a point where the fish can be removed from the regular catch basin, the fish are too crowded to handle fast enough to prevent excessive mortality. When the ponds are not drained to this point, the fish hang back in the channels where it is impossible to seine them satisfactorily. In order to handle the large numbers of fish produced in these ponds, catch basins have been constructed at the outer ends of the drain pipes, that is, on the bank of the creek into which the ponds drain.

These auxiliary catch basins, or a modification, might be useful at other stations having similar unfinished ponds or ponds with muck or unstable bottoms. Construction is simple. (See drawing.) A concrete pad approximately 8 feet square--ours are 5 feet square and have proved too small--is poured level with the bottom of the drain line and extending 8 inches under it. A wall approximately 2 feet high is poured on the rear (inner edge) of the pad and around the mouth of the drain line. Each end of the wall is slotted for screen frames. Concrete posts, 8 inches square and 2 feet high, are poured at each end of the outer corners of the pad--provisions for reinforcement are



made when pouring the pad--and each post is slotted for screen frames on the inner two sides. The construction of suitable screen frames completes the catch basin. Three screens are useful in our basins because of the debris, leaves, and other material which tends to clog the screens in the fall; also, the three screens reduce the tendency for the current through the basin to hold fish against the screen. Perhaps a screen on the outer side and concrete walls on the other three sides would be sufficient in some ponds. The height of the water in the catch basin is controlled with boards or heavy paper placed against the lower sections of the screens.

The flow of water through the pond and this catch basin is regulated to provide fresh water constantly. The constant flow of fresh water is a great advantage. In some ponds the basin might be so constructed as to allow free passage of creek water to improve conditions for holding the fish during seining operations. We

are unlucky enough to have our pond inlets directly across the pond from the outlets, and this tends to hold up the fish, but they gradually work down. With inlet supply at the outlet, there would be no tendency for the fish to hold back.

If plant growth is controlled with proper fertilization, and if the ridges and hummocks are ditched to permit free drainage, it will not be necessary for men to work in the pond being drained.

The number of fish to be handled is controlled by raising and lowering the screen of the regular catch basin within the pond. This is an added advantage because the fish are handled as required. Fish mortality from draining and handling is as low as, or lower than, that in the ponds drained into the regular type of catch basin.

SEPARATION OF NORTHERN PIKE EGGS

Leslie H. Bennett
Fish and Wildlife Service
New London, Minnesota

During the past 6 years the problem of getting northern pike eggs separated properly after fertilization has given considerable trouble at the New London station, but it has finally been solved.

When the pike work was begun at New London, it was supposed that the method of separation used for buffalofish eggs on the Atchafalaya River in southern Louisiana, would be quite as satisfactory for pike eggs. In this we were entirely wrong.

Every fish-culturist is familiar with the condition of the eggs when taken from the wall-eyed pike, northern pike, carp, or buffalofish; but the situation should be described for those who may read this and not understand. When they are taken from the female, the eggs are a soft, sticky mass. This jellylike mass must be separated into individual ova in order that they may be hatched artificially on a hatching battery. Starch, black muck, or clay may be used to effect this separation. Starch, already ground fine, does not have to be prepared for this use; but muck or clay must be dried and sieved through a fine screen to remove all the fine stones, roots, or other foreign substances. The separating agent is mixed with water to the consistency of a good thick cream.

After the eggs are stripped from the females, the milt from the buck is put on and thoroughly spread through the eggs. The spawn-taker hands his pan of eggs to the egg-washer, who puts about one-third of a small dipper of the starch or muck water into the pan of eggs, mixes it thoroughly through the eggs, allows it to stand for a minute, and then proceeds to wash the starch or muck off the eggs in much the same way as a miner pans for gold. When the eggs have been washed well, the sticky mass has become a panful of individual eggs that are ready to be put into a keg or tub of water to harden. The eggs just would not separate into individuals; instead, they grouped themselves in clusters like small bunches of grapes. When placed in the jars, the eggs again formed a jellylike mass, which the flow of water failed to budge. We soon found that we were not going to be able to hatch fish that way, but we were at our wits' end to know what to use.

The writer had worked on wall-eyed pike on the Canadian border near Rainy Lake and had used the northern black muck with

The northern pike eggs, we discovered, were much stickier than those of the carp, wall-eyed pike, or buffalofish. The first year we tried using starch and native black muck. Starch failed to do the job.

consistent success, but it was too late to get any of that. We decided to try native black loam. Immediately we procured some native black loam, processed it as best we could, and started to use it. The first trial of native black loam as a separating agent was most encouraging. The eggs separated in fine shape: apparently they hardened in the tubs--no clusters, no solid jelly, each egg an individual. We set them up in the jars and turned on the water through the tubes. How those eggs did roll in those jars! We thought our worries were over, as far as separation went, but our complacence was short-lived. In about 48 hours, to our surprise, the eggs started to adhere again in the jars although a good flow of water was passing through the tubes. We found that by gently feathering them in the jars, we could keep the eggs moving. Men were detailed at once to feather the eggs on the battery for 24 hours a day. The embryo began to be visible in the egg in about a day and a half; immediately after the embryo started to appear, the sticking seemed to stop. The dead eggs were then separated from the live ones, and the usual work of screening, siphoning, and laying-by proceeded. This, then, was all right; but we were not satisfied. Feathering a battery of eggs was no joke, as it had to be kept up continuously, every hour of the day and night. Two men on 8-hour shifts were used, and something more effective had to be found.

We arranged to get some northern muck, processed it by sieving to get out the twigs, roots, and bark, and then let it dry. Used during the second year, the northern muck did work better than the native muck. Adhesion of the eggs was stopped to an encouraging degree; some feathering was still necessary, but one man could now cope with the situation. A bad feature in using the northern muck was that no matter how carefully it was sifted, fine roots and particles of wood remained, and these tended to accumulate at the tube prongs and hinder the water flow, catching the eggs and causing them to smother--a total loss.

Naturally, we were not satisfied. We told our troubles to any fish-culturist who would listen.

Finally we got a ray of hope. We heard of a fish-culturist in North Dakota who used clay and apparently had no trouble with the eggs sticking. We got some, processed it, and tried it. The clay worked. There was no more sticking or feathering. In the process of incubation, however, the embryo would form and then die. There was a small percentage of survival, but something was toxic to the eggs; we lost most of them. We decided to stick to the northern muck, as it had been the best bet so far.

One day, when hauling sand and gravel on the reservation for fill, we struck a stratum of clear yellow clay. We thought of our Dakota clay and how smoothly those eggs had rolled in the jars. We saved a couple of kegs of this yellow clay, processed it, and proceeded to use it the following spring. It worked. The eggs rolled beautifully, and our percentage was better than normal. The eggs were hard as BB shot when placed in the jar, and we hatched out strong, healthy, and aggressive fry. Our worries about sticky eggs were ended.

RETREAD ON RUBBER BOOTS

Traction can be restored to smooth-soled boots by having new grooves cut into the soles. Walter M. Allen, Superintendent of the U. S. Fish-Cultural Station at Miles City, Montana, reports that use of a regrooving iron borrowed from a tire-repair shop has prolonged for another year the usefulness of the rubber footgear on that station.

FROM PUBLICATIONS

REPRINT

BAIT MINNOWS AND THEIR PROPAGATION

Lynn H. Hutchens
Laboratory Technician
Illinois Natural History Survey

Minnows of a number of species are used as bait for bass, crappie, pickerel, walleyed pike, catfish, and occasionally for bluegill and other fishes. Some fishermen provide themselves with a supply of minnows by seining small streams, drainage ditches, or lake margins. Others buy their minnows enroute to, or on arrival at, the fishing ground. Commercial bait dealers have long been in business at a few popular fishing sites, usually in connection with boat rental services. Others have established themselves at strategic points along routes leading to fishing areas. These operators, in some cases, have contracted with commercial seiners in Lake Michigan for supplies of minnows. More commonly they operate their own seines, a tank truck, and perhaps a compressor for bubbling air through the fish tanks while transporting their hauls of minnows. Inevitably, heavy losses of minnows occur, only to be compensated for by more vigorous seining efforts in the local area. In many regions a rapidly dwindling local supply has required seining crews to range far and wide, to the detriment of the native population of minnows.

In an effort to satisfy the need for live minnows, some anglers have begun using small fish of many species, including small carp and dogfish. Others pay a visit to the 5- and 10-cent store, minnow bucket in hand, and purchase two or three dozen goldfish. There is danger here. Some very fine fishing lakes contained no carp until a thoughtless or careless fisherman used carp "minnows" for bait. Lakes have been contaminated with other species of undesirable fish in the same manner.

The goldfish is no more desirable than carp. Once freed in a lake or stream, they may survive and grow, sometimes to a weight of several pounds. Goldfish, like carp, spawn in prodigious numbers and, a few years after their introduction into a lake, they may seriously compete with game and pan fish.

One answer to the bait problem is the propagation of minnows in artificial ponds. Although more than 40 species of true minnows are native to Illinois, less than a dozen are suited both for propagation in ponds and for use as bait. Others are not practical, because of their small size, slow rate of growth, spawning requirements, or other characteristics. From the angler's standpoint, a desirable bait minnow should be hardy, both on the hook and for transporting in a small minnow bucket. For early spring fishing, minnows of a little less than two inches to two-and-one-half inches are preferred. Later on, when bass and pickerel are sought, minnows of three to six inches are most commonly used. Active, shiny minnows satisfying these requirements are the common shiner, golden shiner, bluntnose minnow, and creek chub.

For the person who intends to raise minnows, either for his own use or as a commercial enterprise, only pond spawning

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species are recommended. For this reason some otherwise desirable minnows are not dealt with here. Unless a person has had considerable experience in fish hatchery techniques, any attempt to propagate stream spawning minnows is more than likely to result in failure. The investment in a spawning shed, hatching jars, water supply, and rearing ponds for such minnows would be large. A great deal more time would be required to manage a hatchery and rearing unit for stream minnows than is necessary for propagation of pond spawning species.

The following species are recommended for pond propagation:

1. Bluntnose minnow, Hyborhynchus notatus (Rafinesque)
2. Fathead minnow, Pimephales promelas promelas (Rafinesque)
3. Golden shiner, Notemigonus crysoleucas (Rafinesque)
4. Silvery minnow, Hybognathus nuchalis nuchalis (Agassiz)
5. Chub sucker, Erimyzon sucetta kenerlii (Girard)--not a minnow, but often used as bait.

Distribution of these five species is nearly statewide. The fathead minnow does not occur in the southeastern part of the state, and the chub sucker is more abundant east of a line drawn through the center of the state from north to south. Spawning requirements of these minnows are simple and easily supplied in a small artificial pond.

Both the fathead and bluntnose minnows deposit their adhesive eggs in layers on the underside of flat objects such as pieces of tile, rocks, and slabs of wood placed at the pond's edge for the purpose. Males guard the eggs and are vigorous in their efforts to drive away intruders. These minnows are hardy, prolific, and popular as live bait. Experimental production of 100,000 to 200,000 per acre has been reported. A considerable reduction in numbers might be necessary to insure a food supply adequate for rapid growth. The spawning season of these species extends from May to August, beginning at a water temperature of about 70 degrees F.; adults reach an average length of 3½ inches. Since fathead minnows die shortly after they have spawned it is desirable to remove and sell all spent breeders.

The golden shiner is a popular minnow because of its bright color, hardiness, and large size. Adults reach the length of 8 to 10 inches. The spawning season is from May to August at water temperatures ranging from 60 degrees to 80 degrees F. The adhesive eggs are deposited among algae and on aquatic plants, hatching in about 10 days. Golden shiners are prolific and are rapid in growth. Shiners of medium to large sizes are predatory on fry of their own and other species.

The silvery minnow does well in mud-bottom ponds containing little or no vegetation. It is not as hardy a minnow as others named above but nevertheless is frequently used as bait. The spawning season is from May or late April through June at water temperatures of 60 degrees to 70 degrees F. The silty material on the shallow pond bottom serves as a locale for spawning. Production under experimental conditions has reached 50,000 per acre. Adults reach a length of 6 inches.

Chub suckers prefer stream spawning conditions but are known to spawn successfully in ponds. Their non-adhesive eggs are deposited over beds of moss, among filamentous algae and on pieces of submerged sod. The spawning season extends from April through June. About 7 days are required for eggs to hatch at a water temperature of 75 degrees F. Chub suckers grow rapidly and to a large size; adults reach a length of 10 inches.

Small ponds, from one-fourth acre to an acre in area, are sufficiently large for minnow propagation. In most cases small ponds are probably more satisfactory than those of large area because the cost of spillway construction is lower, and management problems are more easily solved. The ponds should be supplied with sufficient water, either from a spring or from surface drainage, to insure a fairly constant water level, and for refilling within a reasonable time after drainage. At the time of construction a drain pipe should be incorporated in the dam so that it will be possible to lower the water for seining or for cleaning out the pond. If a drainage outlet is not possible, then every part of the pond should be accessible to a seine.

Shallow water at the edge or tail of a pond favors the growth of aquatic plants, creating a haven for minnows when seining

operations are under way. For this reason, water less than 2 feet in depth is not desirable. To provide a wintering pool, about 30 per cent of the water should be 6 to 8 feet in depth. For the northern third of the state, 8 feet is regarded as necessary, unless pond water is supplied from a spring. For ease of seining, long, narrow ponds are preferable to round ponds.

Production of minnows will be directly related to the soil fertility of the watershed, and of the pond bottom. In parts of Illinois where fair to excellent crop yields are obtained without heavy applications of fertilizer, no fertilizer is recommended for ponds. In areas of poor soils, fertilization may pay for itself in increased production of minnows. In any case the removal of a part of the minnow population is indicated if the growth rate is slow or if the minnows are noticeably thin. Under a system of proper management, minnows should grow to a minimum bait size by the end of the first year after stocking. Chub suckers and golden shiners of the earliest spawning should be of minimum usable size by late summer of the first year. If several ponds are utilized in a rotation system, a constant supply of minnows should be available after the first year of operation.

For convenience in marketing, minnows may be removed from ponds in numbers sufficient to meet immediate demands and held in large tanks of concrete or metal. These are preferable to wooden tanks because of greater ease and efficiency in cleaning. The tanks should be shaded, supplied with a source of cool, clean water, and aerated by forcing compressed air through fine carborundum blocks. Some expense will be involved in this type of equipment but it is well to remember that few fishermen will buy dead minnows or continue to patronize a bait dealer who sells them minnows that die shortly after purchase.

There is opportunity for a substantial income to be derived from the sale of bait minnows. The expenses of the initial outlay for ponds and equipment automatically reduce competition so that in areas where the demand is heavy the sale price remains high, and minnow production insures an income throughout the fishing season.

ABSTRACTS

BOTTOM FAUNA PRODUCTION AND THE PHYSICAL NATURE OF THE SUBSTRATE IN A NORTHERN COLORADO TROUT STREAM. R. W. Pennak and E. D. Van Gerper. Ecology 28 (1): 42-48 (1947).--Observations and collections were made on North St. Vrain Creek in the northern part of Boulder County, Colorado, at an elevation of 1,677 meters. Bottom samples were taken with the square-foot sampler of the Fish and Wildlife Service. About 98 percent of the bottom organisms were Plecoptera and Ephemeroptera nymphs; 39 percent of all individuals belonged to the genus Pseudocloeon (Ephemeroptera). The average number of organisms for rubble, bedrock, gravel, and sand were 610, 551, 575, and 202 per square meter, respectively. Corresponding net weights were 2.5, 1.7, 1.3, and 0.6 grams per square meter.

MANURING OF PONDS AND ARTIFICIAL FEEDING OF FISHES. Sunder Lal Hora. Indian Farming 4 (11): 559-562 (1943), Biol. Abs. 20: 9691 (1946).--Success of carp culture depends on manuring ponds and on supplemental feeding. By liming and adding N and P manures, both organic and inorganic, a rich production of phytoplankton is promoted. Supplemental feeding with cattle droppings, oil cake, damaged cereals, or slaughter-house refuse is suggested.

LIMNOLOGICAL STUDIES OF WESTERN LAKE ERIE. V. RELATION OF LIMNOLOGICAL AND METEOROLOGICAL CONDITIONS TO THE PRODUCTION OF PHYTOPLANKTON IN 1942. D. C. Chandler and O. B. Weeks. Ecol. Monogr. 15 (4): 343-392 (1945), Biol. Abs. 20: 9671 (1946).--Vernal populations of phytoplankton in western Lake Erie were controlled by physical rather than chemical factors. Phytoplankton production during fall periods apparently is controlled by both physical and chemical factors. Nitrate N made up 50 to 98 percent of the inorganic N. Phosphate P averaged 29 percent of the total P. Largest concentrations of N and P were found in spring and late fall. Data indicated that concentration of inorganic N varied directly with the river discharge from the southwest drainage system of Lake Erie.

THE MEANS OF DISPERSAL OF BATHYPELAGIC ANIMALS IN THE NORTH AND SOUTH ATLANTIC OCEANS. W. P. Coe. Am. Nat. 80 (793): 453-469 (1946).--In addition to the superficial ocean currents, there are currents constantly flowing far beneath the surface. The direction of flow of the deeper currents may be at any angle with the superficial currents, and their populations may be carried in different directions. The superficial currents carry both animals and plants, while those at deeper levels carry animals only. The ocean currents are responsible for the wide distribution of many species and for the destruction of many individuals by transporting them into unfavorable environments. The principal breeding area of the eels lies in the ocean north and northeast of the West Indies. The American eel breeds in an area somewhat farther west and south than the European species, and surface currents carry the young to the North American coast from Florida to Labrador. The surface currents prevailing in the breeding area of the European eel carry the young eastward to the coasts of Europe and northern Africa. The bathypelagic fauna has been most thoroughly investigated in the Bermuda area. Because of the wide circulation of ocean currents, it seems possible that the bathypelagic fauna inhabiting any part of the north or south Atlantic may from time to time drift through the Bermuda area.

THE AGE AND GROWTH OF EELS (Anguilla anguilla) FROM THE WINDERMERE CATCHMENT AREA. W. E. Frost. Jour. Animal Ecol. 14: 26-36, 106-124, 12 figs. (1945), Biol. Abs. 20: 11565 (1946).--The age of both yellow and silver eels was determined by marking on scales and otoliths and correlated with length and weight. Female silver eels had spent 9 to 19 years in fresh water, were 47 to 95 centimeters long, and weighed 210 to 2,040 grams. Male silver eels had spent 7 to 12 years in fresh water, were 40 centimeters long, and weighed 112 grams. Most eels migrate when 54 to 60 centimeters long although their ages vary.

THE FLIGHT OF FLYING FISHES. G. S. Carter. Endeavor (London) 4 (16): 136-140 (1945), Biol. Abs. 20: 11561 (1946).--Cypselurus glides about 1 foot above water, and the average flight lasts about 2.6 seconds and covers some 40 yards. Experiments with dried fish in a wind tunnel indicate that the fish would fly above 25 miles per hour and, with an initial speed of 40 miles an hour, would cover 30 yards in 1.7 seconds.

LA PÊCHE EN EAU DOUCE AU CONGO BELGE. A. Duren, H. Gillet, H. Huet, and M. Poll. Bull. Agric. Congo Belge. 34 (1/2): 111-162 (1943), Biol. Abs. 20: 9685 (1946).--Includes general consideration of the hydrobiology of equatorial waters, the biological cycle in fresh waters, and fish culture in that area. Descriptions, habits, and ecology of freshwater fishes are discussed.

THE PACIFIC SALMON IN BRITISH COLUMBIA WATERS. W. A. Clemens. Rept. British Columbia Fish. Dept. 1943: 83-85 (1944), Biol. Abs. 20: 11562 (1946).--A brief account of the life histories and taxonomy

CLEARING HOUSE

As a convenience for those interested in the various phases of fishery work, the PROGRESSIVE FISH-CULTURIST proposes to list in each issue recent publications on fishery topics. At present there is no current listing of new and pertinent publications. In order to keep up with new literature relating to their work, men in the field must now depend upon private correspondence, a few tardy abstracts and reviews, and personal contacts. Thus it is suggested that any State, institution, or other source that publishes a bulletin on farm-pond management, fish culture, fishery research, or other subject of interest to the fishery field in general, furnish the PROGRESSIVE FISH-CULTURIST with the name of the publication, the name of the author, the source from which copies may be obtained, and, if possible, a copy of the publication.

of five species of Pacific salmon.

PILCHARD TAGGING AND PILCHARD TAG RECOVERY FROM 1936 to 1943. J. L. Hart. Rept. British Columbia Fish. Dept. 1943: 43-52 (1944), Biol. Abs. 20: 9689 (1946).-- Internal metal tags, recovered on electromagnets in reduction plants, were used to trace the movements of pilchards. There was a definite migration between British Columbia and California.

BOTTOM-PREFERENCE OF FISHES IN NORTHEAST KENTUCKY STREAM. W. R. Allen and M. E. Clark. Trans. Ky. Acad. Sci. 11 (2): 26-30 (1943), Biol. Abs. 20 (3): 4411.-- Most species were found where the stream had a sand or gravel bottom. This may be due to preference for these types of bottoms or for a moderately swift current.

AQUATIC PLANT CONTROL WITH 2,4-D. E. W. Surber. Fishery Leaflet 217, 5 pp. (processed) 1947. U. S. Department of Interior, Fish and Wildlife Service, Chicago 54, Illinois.

This leaflet presents a summary of the most effective known methods of using 2,4-D to control obnoxious vegetation such as cattail, spikerush, round-stem bulrush, burreed, willow, and waterlily. Also included are formulas for spray solutions (cosolvents and carriers used with 2,4-D).

FISH BAITS: THEIR COLLECTION, CARE, PREPARATION AND PROPAGATION. Division of Gamefish and Hatcheries. Fishery Leaflet 28, 23 pp. (processed) rev. Sept. 1946. U. S. Department of Interior, Fish and Wildlife Service, Chicago 54, Illinois.

This leaflet summarizes information regarding the collection and propagation of various types of natural baits: crayfish, fiddler crabs, earthworms, clam worms and sandworms, crickets and roaches, mealworms, frogs, salamanders, hellgramites and other aquatic forms, minnows, goldfish, stone cat and other small catfishes, and mice. The section on preservation and preparation of baits deals with minnows, cut-bait, carp bait, "stink" bait, salmon eggs, and pork rind. Also included is information about Spanish gut leader, fish hooks, and water-proofing dry flies. The 2-page bibliography lists additional material on most of these topics.

COMMENTS FROM READERS

No Hits, No Runs, No Errors!

Nonsense! Nevertheless, we feel that with this third issue we are bringing your new PROGRESSIVE FISH-CULTURIST into the stretch for this first year, and we'd like very much to know how you score it.

With the new batting line-up, of course, there have been some changes. (We hope there will be more.) What angles would you like to see covered? What strategy do you think we should follow? We may not have hit any homers, but what do you think of the way the bases are filled? What do you think about the coaches?

From where we stand, it looks as though the fans could take a little more excitement. We haven't seen anybody throwing bottles. If anybody's been hit by a foul, we haven't heard about it. Even a healthy yell--"Kill the umpire!--would be welcome, showing that the bleachers weren't devoting all their attention to the soap operas coming over their portable radios.

Say, why don't you put on a suit and come down and pitch a few over the plate? No further invitation needed in this league.

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Contributions for publication in the PROGRESSIVE FISH-CULTURIST are always welcome. Good illustrations (in the form of glossy prints) add considerably to the value of most papers. Manuscripts and correspondence should be directed to the Editor, PROGRESSIVE FISH-CULTURIST, Fish and Wildlife Service, Merchandise Mart, Chicago 54, Illinois.

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